Technical, Psychological, and Economic Aspects of DIEP Flap Breast Reconstruction

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Voor Joanna, Anouk en Kaia

Boris hield van klimmen
Klimmen op de berg
Het was wel steil, maar dat vond
Boris juist niet erg

Want als hij dan daarboven
Op die bergtop stond
Kon hij heel ver kijken
Wat hij prachtig vond

Uit "Boris op de berg", Dick Bruna

CONTENTS

General introduction and outline of thesis

BREAST CANCER

In the Western world the incidence of breast cancer (BC) is high. In the Netherlands the lifetime risk for women to develop BC is around 13%, making it the most common form of cancer among women with approximately 12.000 women being diagnosed annually.[1] Also, increasing numbers of women are being identified to be genetically predisposed to develop BC due to a known mutation (e.g., BRCA 1 or 2) or a strong family history.

Continuous progress in early detection, diagnostics and treatment of BC have produced significant improvements in disease-free and breast cancer related survival. Despite these advances, mastectomy remains an important surgical option to either adequately manage the disease locally (therapeutic mastectomy) or reduce the significantly increased risk of developing BC in genetically predisposed women (prophylactic mastectomy).[2-4] This mutilating procedure is a potentially traumatic event in a woman's life, and a wide range of lasting psychological adjustment problems has been described.[5-9]

BREAST RECONSTRUCTION

Breast reconstruction (BR) is aimed at restoring the amputated breast and thus improving patients' quality of life and body image after mastectomy. Psychological, social, emotional and functional benefits of BR, including improved psychological health, self-esteem, sexuality, and body image have been documented.[10-16]

Currently, approximately 5-45% of women who undergo a therapeutic mastectomy receive BR; in the Netherlands, this percentage is about 15%.[17-24] There is a high regional variance in post-mastectomy BR rates.[17,23,25,26] Reasons for the rather low BR rates are multifactorial, including the attitudes and biases of the referring breast surgeon, as well as patient factors. Reasons cited for general surgeons not to refer patients included the concerns over cancer recurrence, need for radiation therapy, delaying adjuvant oncologic treatment, and advanced patient age. Reasons for patients not to undergo reconstruction included patient's refusal, resistance to receive foreign material in their body, and unavailability of a local plastic surgeon.[27-31]

Women who choose to have a reconstruction tend to be younger, are more likely to be well-educated, Caucasian, affluent and married or having a relationship.[17,25,32] The most common reasons for reconstruction are to get rid of the external breast prosthesis, to be able to wear a greater variety of clothes and to restore feelings of wholeness and body integrity.[24,33]

Breast reconstruction techniques have evolved and improved over the past decades and have been shown to be oncologically safe.[34,35] There are essentially three types of breast reconstruction, using either 1) implant material, 2) autologous tissue, or 3) a combination of both. Techniques differ in characteristics such as material used, duration of the operation(s), recovery period, complication rates, aesthetic result, and costs. Each technique has its own advantages and disadvantages and therefore its own place in current practice. The most frequently performed techniques are described below.

Breast reconstruction can be performed directly after mastectomy (direct or primary BR) or at a later stage (delayed or secondary BR). Primary breast reconstruction after skin sparing

mastectomy offers technical benefits as important landmarks such as the infra-mammary fold (IMF) and the skin envelope can be preserved. Primary breast reconstruction yields superior aesthetic results, but it is practically more challenging to organize. In the Netherlands, delayed or secondary BR is by far more common; the percentage of primary BR is low compared to other countries.[36,37] Factors limiting immediate BR are patient comorbidities, potential complications caused by adjuvant (radio)therapy, and attitudes and biases of the referring breast surgeon.[38-40] Primary reconstructions are predominantly performed in genetically predisposed women, who choose to undergo prophylactic bilateral mastectomy. Secondary BR is generally performed at least 6-12 months after the mastectomy or after completion of adjuvant therapy.[41] Revisional BR after failure of previous BR is called tertiary BR.[42]

1 IMPLANT MATERIAL

Silicone prosthesis or implant (SP)

If sufficient, good quality skin is available and the pectoralis major muscle is intact to cover the implant, subpectorally placed implants are the easiest and most straightforward way to reconstruct a breast. The mastectomy scar is used and there is no need for additional scarring. In 2009, 76% of BR in the USA were implant-based procedures.[43]

Since the introduction of silicone and saline breast prostheses in the early 1960s, the quality of implant material has improved dramatically. Some problems such as leakage and wrinkling have diminished, while other (long-term) disadvantages remain. Infections, implant displacement, and (painful) capsular contracture may require implant replacement or removal, or may result in chronic pain and tightness.[44-47] In addition, the aesthetic result may deteriorate over time because of the implants' inability to become ptotic with age or adjust for weight gain.[48] Especially in unilateral reconstructions this may cause progressive asymmetry. Adjuvant radiation therapy is increasingly considered a contra-indication as it further increases complication rates and has a negative effect on patient satisfaction.[49,50]

Single-stage SP reconstructions, however, are not suitable for all patients and are only recommended in distinct situations, depending on the size and shape of the (contralateral) breast as well as the quality of chest wall soft tissues, for example primary reconstructions in non-irradiated patients with smaller breasts.[51]

Silicone prosthesis preceded by tissue expansion (TE/SP)

If insufficient, yet good quality chest wall skin is available and the pectoralis major muscle is still intact, the muscle and overlying skin can be first expanded using a tissue expander. Tissue expansion can be performed in both primary and secondary cases. Again, no additional scarring is required. A temporarily tissue expander is placed in a pocket under the pectoralis major muscle. Subsequently, saline solution is percutaneously injected to progressively expand the overlaying tissue, which requires a commitment to visit the outpatient clinic regularly over a period of several months. Once the expander has reached an acceptable size, it is replaced by a permanent implant during a second operation. In selected cases, definite, single-stage tissue expanders may be used. The advantage of a

two-stage approach is that during the second procedure additional corrections to the position of the implant and IMF can be performed, optimizing the final result.
Short-term complication rates after TE/SP reconstructions are similar (or even higher due to the expansion process) compared to those after SP reconstructions. In contrast, long-term complications such as capsular contraction are reduced. Radiation therapy, however, remains a contra-indication.[49,52]

2 AUTOLOGOUS TISSUE

Background

If the quality or quantity of chest wall skin is insufficient to directly place an implant (e.g., after radiation therapy) or if the pectoralis major muscle has been removed, additional soft tissue coverage is required to reconstruct a breast. Autologous tissue from the patients' own body can provide soft tissue coverage as well as bulk for the new breast(s), depending on the donor-site used. If no additional implant material is required, long-term risks such as capsular contracture are eliminated altogether.

BR using only autologous tissue is generally considered to yield superior aesthetic results. The reconstructed breast appears and feels natural with a similar consistency and temperature to the native breast. In contrast to implant-based reconstructions it behaves like a normal breast, which becomes softer and more ptotic with age and it changes in accordance with bodyweight fluctuations.[48] Compared to implant BR, however, autologous BR requires more (micro)surgical expertise, longer operation times and hospital admittance, and always involves additional donor-site scarring.

Abdominal donor-site

The abdominal tissue between umbilicus and pubis is most frequently used. It forms a perfect natural match for amputated breast tissue and it frequently supplies enough excess bulk to reconstruct even large breasts. The contour of the lower abdomen is reliably improved by these procedures, as closure of the abdominal donor-site is identical to an aesthetic abdominoplasty. Harvesting abdominal tissue including supplying blood vessels, however, may weaken the abdominal wall and torso strength. Techniques have evolved over the last 30 years, especially in an effort to reduce donor-site morbidity.

Transverse rectus abdominis musculocutaneous flap (TRAM)

In 1982, Hartrampf et al. introduced the transverse rectus abdominis musculocutaneous (TRAM) flap.[53] The evolution started with the pedicled flap, which incorporates the abdominal wall's secondary blood supply through the deep superior epigastric vessels in the rectus abdominis muscle. This flap is often associated with decreased abdominal wall strength and suboptimal venous outflow leading to a higher rate of fat necrosis.
Next, the free TRAM flap was described, based on the deep inferior epigastric vessels.[54] While flap circulation benefitted from the use of the abdominal wall's dominant blood supply, donor-site complications as herniation, bulging, and weakening remained, especially in bilateral reconstructions.[55,56]

Deep inferior epigastric perforator flap (DIEP)

In the late eighties and early nineties, the deep inferior epigastric perforator (DIEP) flap was introduced and popularised as an alternative to TRAM flaps.[57-59] Flap circulation is supplied through one or more perforators from the deep inferior epigastric vessels, while preserving the abdominal wall and therefore minimizing donor-site morbidity and postoperative pain. Despite these efforts, though, rectus abdominis muscle function may still be compromised.

Free flap BR in general and perforator flap techniques in particular require more advanced microsurgical techniques and meticulous dissection of small perforating vessels through muscles. These procedures are consequently more time consuming and therefore less common.

Superficial inferior epigastric artery flap (SIEA)

Abdominal flaps based on the superficial inferior epigastric artery (SIEA flap) provide the least donor-site morbidity, as dissection of the rectus abdominis sheath and muscle is not required. Recent prospective studies have confirmed a significantly greater decline in upper abdominal strength in patients undergoing breast reconstruction using muscle-sparing TRAM flaps compared with DIEP flaps and SIEA flaps.[55,56]

However, because of inconsistencies in the existence and size of the superficial inferior epigastric artery, its use for breast reconstruction is limited. Some authors recommend exploring the superficial inferior epigastric artery prior to converting to a DIEP flap.[60]

Alternative donor-sites

If the abdomen does not supply sufficient tissue or if contra-indications prevent its use, the back (pedicled latissimus dorsi (LD) flap), buttocks (free superior or inferior gluteal artery perforator (S-GAP; I-GAP) flap) or the inner thigh (free transverse musculocutaneous gracilis (TMG) flap) can be used as alternatives.[61-63]

3 AUTOLOGOUS TISSUE COMBINED WITH IMPLANT MATERIAL

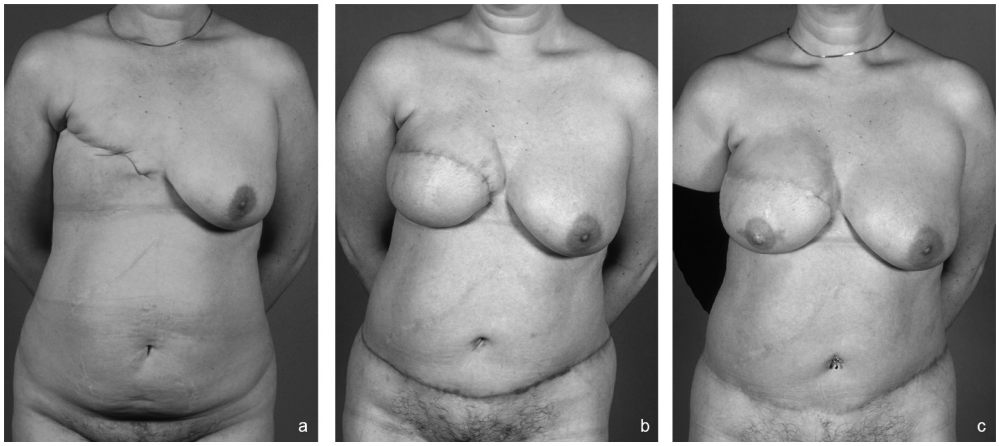
Latissimus dorsi flap with implant (LD + SP)

Additional soft tissue coverage can also be supplied by transposing the latissimus dorsi (LD) flap from the back to the chest wall. The LD transposition, consisting of the latissimus dorsi muscle and overlying skin vascularized by the thoracodorsal vessels, is the most frequent source of additional autologous tissue. As this pedicled technique does not require microsurgical techniques, it is less demanding for both the patient and the surgeon. Donor-site morbidity and loss of function are limited. This flap usually does not supply enough volume to reconstruct a breast, requiring the use of an additional implant. The use of implant material is always associated with a risk of capsular contracture, but it decreases when implant material is combined with additional autologous tissue.[64]

ADDITIONAL OPERATIONS AND NIPPLE AREOLA RECONSTRUCTION

Regardless of the type of breast reconstruction, three stages can generally be identified: 1) breast mound and IMF creation, 2) nipple reconstruction, and 3) nipple areola complex tattooing (Figure 1). Additional operations are sometimes necessary to deal with complications or to improve the aesthetic result.

Figure 1 | Unilateral secondary DIEP flap breast reconstruction: a) preoperatively; b) postoperatively; c) final result after nipple reconstruction and nipple areola complex tattooing.



In conclusion, breast reconstructive techniques differ with regard to material used, duration of the operation(s), recovery period, complication rates, aesthetic result, and costs. Each technique has (dis)advantages and therefore its own place in current practice. Multiple factors have to be considered to assess which methods are technically feasible and which risks acceptable in order to determine the optimal treatment modality for individual patients.[65]

To allow patients who are facing the consequences of mastectomy to make a conscious and deliberate decision about BR, accurate patient information is of vital importance.[66] It should include positive as well as negative aspects, offering a truthful perspective of the entire reconstruction process. Patient expectations have previously been shown to significantly affect psychological outcome after different types of BR.[67,68] Unfulfilled and inaccurate expectations can lead to patient dissatisfaction with surgical outcomes.[69] As reconstructive breast surgery is primarily aimed at satisfying the patient with respect to her own preferences and expectations, individualized selection of a reconstructive technique is paramount.

HISTORICAL BACKGROUND OF THIS THESIS

In 2002, the DIEP flap was introduced in the Erasmus University Medical Centre (Erasmus MC) in Rotterdam, the Netherlands, and quickly became the preferred method to supply autologous tissue for breast reconstruction. From its introduction, patients were included in a prospective database, in which patient characteristics, medical history, surgical data, and complications were collected. At the start of this research project in 2006, approximately 150 patients had been incorporated, enabling specific questions regarding technical aspects and outcome of this relatively new technique to be addressed. The DIEP flap shows major resemblance to the TRAM flap, which has already been studied in great detail, but distinct differences warrant research focusing on this specific method.

Simultaneously, the waiting list for autologous breast reconstruction at the Erasmus MC had gone up to more than two years. Interest in and demand for autologous BR rose dramatically, while the number of procedures was not increased accordingly. As this technique requires advanced microsurgical skills and experience, it is primarily offered in large (university) hospitals. In addition, because the prolonged operation times weigh heavily on the hospital organisation and the financial compensation was not deemed adequate, the number of operations was often restricted by hospital boards.
The waiting list problems caused uproar amongst patients and drew media attention, which further triggered this research project and added specific interest into the economic implications of autologous BR in comparison to other types of BR.

AIMS OF THIS THESIS

As a result, several studies were designed to provide a global overview of technical, psychological, and economic aspects of DIEP flap BR.

Technical aspects

It is important – especially when introducing a new technique – to critically assess your own results and to benchmark these with those of others. In an attempt to further elucidate the role of this reconstructive technique in current practice, as well as reduce our complication rates, improve aesthetic outcome, patient satisfaction, and preoperative patient information, we wanted to assess several specific technical aspects:

- complication rates in relation to surgical experience (learning curve);
- patients' risk factors in relation to complications to identify high-risk patients;
- perioperative and intraoperative decisions involving donor and recipient vessel selection, flap choice, and management of complications in relation to outcome (algorithm);
- the number of additional operations to achieve a satisfactory result;
- complications and outcomes of autologous breast reconstructions after failed implant BR (tertiary BR).

Psychological aspects

To assess the quality and effectiveness of BR, clinical outcome measures such as complication rates do not suffice. In addition, patient satisfaction and the impact of the procedure on health-related quality of life (HRQoL) should be evaluated in relation to patient's expectations. These and other psychological aspects, such as body image and sexuality, were therefore incorporated in several studies assessing technical aspects.

Economic aspects

In addition to technical and psychological aspects, cost and benefit factors have to be taken into account as well. Especially when a multiplicity of techniques is available for the treatment of a particular disease, cost and outcome studies are important to demonstrate procedures' economic viability and ensure its unrestricted, continued availability. In the Netherlands, for example, free flap BR is generally believed to be more expensive than implant BR, which provides implant-based BR a considerable advantage to insurance companies and might indirectly limit the availability of autologous BR. We wanted to compare costs of DIEP flap BR to those of three other commonly used reconstruction types.

In a health economic evaluation, costs and benefits of alternative treatment options under consideration are compared. Traditional means of measuring these benefits have concentrated on improvements in health outcomes using clinical outcomes and Quality Adjusted Life Years (QALYs). The QALY is a measure of the quantity of life gained weighed by the quality of that life.[70] QALYs, however, primarily capture health outcome benefits,[71-73] while total benefits of an intervention can also be derived from non-health outcomes (e.g., patient satisfaction, aesthetic result) and process characteristics (e.g., number of operations, waiting list). Especially for interventions that do not provide reduction in morbidity or mortality (e.g., breast reconstruction), these aspects are potentially more relevant for individuals' preferences and acceptability of specific techniques.[74]

A discrete choice experiment is a technique for investigating individual preferences and provides opportunities for evaluation of the relative importance of health and non-health outcomes as well as process effects, providing additional information to a traditional QALY analysis. We wanted to use this technique to investigate patients' preferences for different types of BR. As reconstructive techniques differ, we wanted to know which aspects are most important, what the relative importance of these attributes is, and which trade-offs individuals are willing to make between them. In other words, which technique do they generally prefer and why?

OUTLINE OF THIS THESIS

The studies presented in this thesis were performed at the department of Plastic, Reconstructive and Hand Surgery of the Erasmus MC in conjunction with the department of Public Health of the Erasmus MC. These studies were conducted in a population of patients who underwent DIEP flap BR at the Erasmus MC between 2002 and 2009 (n = 253)

or who had received either a mastectomy and/or a BR at the Erasmus MC between 2002 and 2009 (n = 820).

Chapter 2

DIEP flap breast reconstruction requires advanced microsurgical expertise. The purpose of this study was to critically assess intra- and postoperative problems of our first 175 consecutive DIEP flap BRs and the effect of the surgeon's learning curve on the number of complications. Furthermore, patient characteristics and risk factors were related to surgical outcome in order to decide which patients are suitable candidates for this procedure.

Chapter 3

Multiple perioperative and intraoperative decisions involving flap choice, donor and recipient vessel selection, and early recognition and management of complications can determine the success or failure of microsurgical breast reconstruction. The purpose of this study was to retrospectively review a single surgeon's experience with 406 microsurgical breast reconstructions to develop practical algorithms to facilitate decision-making and increase the rate of successful outcomes.

Chapter 4

As mentioned previously, breast reconstruction is generally performed in multiple stages. Additional procedures after breast reconstructions have been evaluated previously, but specific information on the number and type of additional operations after DIEP flap breast reconstruction is limited. The purpose of this study was to evaluate the total number of operations needed after DIEP flap breast reconstruction to achieve an aesthetically pleasing end result. Patient satisfaction was assessed using a study-specific questionnaire. Seventy-two patients who had completed their breast reconstruction were identified in our database. Patients representing our learning curve (as shown in **chapter 2**) were excluded.

Chapter 5

Current literature indicates that BR using autologous tissue provides patients with a higher degree of satisfaction as far as aesthetic aspects are concerned, but studies specifically focusing on patient satisfaction and HRQoL after DIEP flap BRs are limited.[75-77] This study aimed at exploring patient satisfaction and its determinants in women undergoing DIEP flap BR as well as the impact of the procedure on body image and sexuality. Patient satisfaction and HRQoL were studied in 72 women who underwent DIEP flap BR, using a study-specific questionnaire as well as the Short Form-36 (SF-36).

Chapter 6

Most breast reconstructions are performed using implant material – in 2009, 76% of BR in the USA were implant-based procedures.[43] In the long-term, implant-based reconstructions are frequently affected by capsular contracture. Capsular contracture may require implant replacement or removal, or may result in chronic pain and tightness. Even without implant explantation due to capsular contracture or infection, some patients are dissatisfied with the aesthetic result of implant reconstruction.[43]

An increasing number of women request conversion of their (failed) implant BR into autologous BR and these numbers are expected to increase further as there is a huge backlog of women who have undergone implant BR over the last decades. BR in patients who previously underwent any form of BR is defined as tertiary BR. Specific literature on outcome of tertiary BR using autologous tissue is limited.[43,78-82] The purpose of this study was threefold: 1) to evaluate surgical outcome and complications; 2) to assess patient motivation and satisfaction with the aesthetic result; and 3) to objectively assess aesthetic outcome after tertiary BR using free flaps. Forty-two women in our database had undergone tertiary free flap BR, using either a DIEP, mini-TRAM or TMG flap. Surgical outcome and complications were evaluated. Patient satisfaction was assessed using a study-specific questionnaire. Aesthetic result was rated by an expert panel using standardized photographs.

Chapter 7

Previous studies did compare costs of different types of BR, but without properly incorporating some important health economic aspects. The aim of this study was to comprehensively assess the financial implications of four BR techniques (silicone prosthesis, silicone prosthesis preceded by tissue expansion, latissimus dorsi transposition with or without silicone prosthesis, and DIEP flaps) from a societal perspective based on real resource use in substantial patient groups.

A prospective historic cohort study was performed to evaluate intramural medical costs in 427 patients who had undergone BR. Additionally, 58 patients who had recently undergone BR participated in a questionnaire study to prospectively evaluate extramural medical and non-medical costs.

Chapter 8

In addition to the medical analysis performed by the plastic surgeon regarding which BR type individual patients could undergo, patients' preferences also play an important role when deciding on the optimal treatment modality. What do patients generally want and how do they weigh different characteristics of BR? Understanding the motivational factors and views underlying women's decision regarding breast reconstruction can contribute to further improve patient-centred and demand-led healthcare and may contribute to a shared decision-making process, better psychosocial counselling and care.

We used a discrete choice experiment (DCE) to explore patients' preferences for different BR modalities after (prophylactic) mastectomy. For this study, 386 patients who previously underwent a therapeutic or prophylactic mastectomy, with or without subsequent BR, were approached. Respondents were repetitively offered a choice between different treatment options and asked to choose the option that appealed most to them. The choice data allow for analysis of the relative importance of treatment characteristics and the trade-offs patients make between them, which provides useful insight into consumers' demands regarding BR, especially because non-health outcomes and process characteristics that would be 'ignored' in clinical outcomes or QALYs were also incorporated. Patients' preferences are presented as relative utility (or benefit) scores, allowing direct comparison between and ranking of techniques.

SUMMARY

In conclusion, this thesis set out to answer the following research questions:

- What is the effect of the surgeon's learning curve, patient characteristics, and risk factors on the complication rate after DIEP flap BR? **(Chapter 2)**
- Which algorithms can be developed to facilitate perioperative and intraoperative decision-making and increase the success rate of microsurgical breast reconstruction? **(Chapter 3)**
- How many additional operations are required after DIEP flap breast reconstruction to achieve a pleasing end result? **(Chapter 4)**
- How satisfied are patients after undergoing DIEP flap BR and what is the impact of this procedure on body image, sexuality and quality of life? **(Chapter 5)**
- What are the surgical outcome, patient satisfaction, and aesthetic result after tertiary autologous BR? **(Chapter 6)**
- What are the cost implications of four BR techniques? **(Chapter 7)**
- Which preferences do patients have with regard to different BR modalities and which trade-offs do they make between treatment characteristics? **(Chapter 8)**.

In the general discussion **(chapter 9)** results of the aforementioned studies are briefly discussed, an analysis is made whether the results have met the aims of this thesis, and potential directions for future studies are addressed. The studies described in this thesis are summarized in **chapter 10** (English) and **chapter 11** (Dutch).

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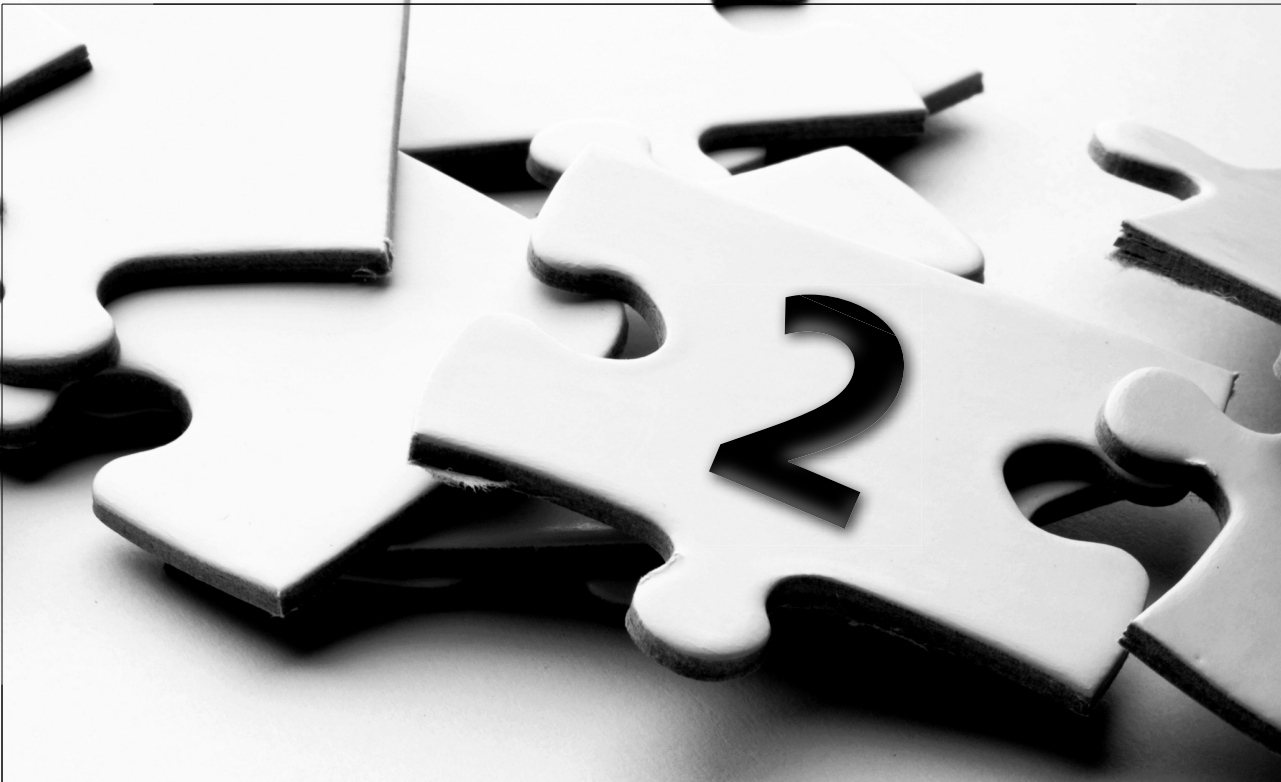

A critical review of perioperative complications in 175 free deep inferior epigastric perforator flap breast reconstructions

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ABSTRACT

Background

The purpose of this study was to critically evaluate the perioperative complications for deep inferior epigastric perforator (DIEP) flap breast reconstruction.

Methods

From February 2002 until February 2006, 175 consecutive abdominal free tissue breast reconstructions were performed in 131 patients. Perioperative risk factors and complications were evaluated for the entire group. Data analysis was performed to compare subsequent chronologic groups for a learning curve effect.

Results

In 159 cases (90.9%) a DIEP flap could be raised. In 13 cases (7.4%), a mini-TRAM flap and in 3 cases (1.7%) a regular free TRAM flap was harvested. A learning curve was found showing a risk for flap complications in the first 30 DIEP flaps of 40% and in flaps 31 to 175 of 13.8% ($p < 0.012$). Microsurgical revision rate was 4% ($n = 7$), with a total flap failure rate of 0.6% ($n = 1$). Partial flap failure rate was 8.6% ($n = 15$), which was solved by debridement, medial advancement, and direct closure in 6.8% ($n = 12$) and latissimus dorsi flap transposition in 1.8% ($n = 3$). Multivariate analysis showed no significant influence of risk factors on development of postoperative flap complications.

Conclusions

DIEP flap breast reconstruction is an excellent method, with limited donor-site morbidity. A definite learning curve was reflected in a larger number of flap complications in the beginning of our series.

INTRODUCTION

Detection and treatment of breast cancer have improved over the past years, leading to better survival rates, contributing to an increasing demand for breast reconstruction. Currently, there are essentially 3 types of breast reconstruction: with implant material, with autologous tissue, or with a combination of both.

Breast reconstructions that involve implant materials are generally propagated as simpler methods, which require less invasive procedures, with adequate results. This is not always true since over 30% of complications leading to implant removal in 14% have been reported.[1] Cosmetic outcome can be inadequate because of the rather high prevalence of late complications such as implant displacement or capsular contracture, requiring implant replacement or removal in up to 50%.[2]

Deep inferior epigastric perforator (DIEP) flap breast reconstruction is gaining popularity; there still remains hesitance to fully embrace this technique. It is difficult to estimate pitfalls and (im)possibilities from literature for performing this technique of breast reconstruction when starting out.

The purpose of this study was to evaluate DIEP flap breast reconstruction by critical assessment of intra- and postoperative problems in 175 consecutive breast reconstructions with autologous abdominal free flaps. Furthermore, relationships between patient characteristics and surgical outcome were evaluated.

PATIENTS AND METHODS

Patient sample characteristics

Two plastic surgeons (S.O.P.H.; N.A.R.) with microsurgical experience started a DIEP flap breast reconstruction practice. From February 2002 until February 2006, 175 consecutive abdominal free tissue breast reconstructions were performed in 131 patients, with an average follow-up of 1.8 years (range, 0.3 to 4.3 years). Patient characteristics are presented in detail in Table 1.

DIEP flap key points

The cranial scar of the DIEP flap was above the umbilicus and the caudal scar above the pubic bone to supply the flap with vertical heights between 12 and 18 cm. The superficial venous system was dissected, if present. A single perforator was chosen if the vein was 1.5 mm or larger. The size of the artery was never considered in this decision. If more perforators were in rows and less than 1 cm of muscle and no nerve had to be transected, a second or third perforator was added, even if the first perforator was judged adequate. Two or more perforators in a row were always used when individual veins were smaller than 1.5 mm. When flap circulation was judged as insufficient, requiring more perforators, which were not in line and needed more than 1 cm of muscle resection, a muscle-sparing TRAM flap was dissected. In case medial and lateral row perforators were required for adequate circulation, a fascia-sparing TRAM flap was dissected.

Table 1 | Patient characteristics of 131 patients who underwent 175 autologous tissue breast reconstructions between February 2002 and February 2006.

General		
Mean age in years (SD; range)	48	(9; 23 – 73)
Mean BMI (SD; range)	27	(4; 18 – 35)
Systemic risk factors (n; %)		
Smoking	17	13
Diabetes mellitus	5	4
Hypertension	19	15
Von Willebrand deficiency	2	2
None	88	67
Previous abdominal operations (n; %)		
Laparoscopy	29	22
Pfannenstiel	37	28
Appendectomy	20	15
Open cholecystecomy	3	2
Umbilical hernia repair	2	2
Mini abdominoplasty	1	1
More than one operation	17	13
Total	74*	56*
Site of breast reconstruction (n; %)		
Unilateral	87	66
Bilateral	44	34
Timing of breast reconstruction (n; %)		
Primary	44	25
Secondary	103	59
Tertiary	28	16
Mean time since mastectomy in years (SD; range)	3.6	(4.4; 0.2 – 29)
Condition requiring breast reconstruction (n; %)		
Oncologic mastectomy	120	69
Prophylactic mastectomy	50	29
Failed cosmetic breast augmentation	5	3
(Neo) adjuvant therapy (n; %)		
None	45	34
Radiotherapy	49	37
Chemotherapy	69	53
Hormonal	35	27
Combination	56	43

* Total number of patients with one or more previous abdominal operations.

The internal mammary vessels were used as recipient vessels through a third or fourth rib cartilage resection approach. In case of evident venous congestion, the superficial epigastric vein was opened for additional drainage and was connected to either a side branch of the main pedicle or to the distally transected and transposed cephalic vein. For unilateral breast reconstruction, zones 1 and 3 were always kept, zone 2 was discarded as far as possible, and zone 4 entirely. In bilateral breast reconstructions, zones were not an issue.

Primary, or immediate, breast reconstructions were performed as skin-sparing procedures. For secondary, or delayed, breast reconstructions, the chest wall skin between the mastectomy scar and the new inframammary fold (IMF), 2 cm higher than the contralateral IMF, was discarded. Tertiary breast reconstructions in patients who had undergone a previous reconstruction were performed in either fashion, depending on the quality of the local skin and the position of the IMF.

Flap inset for optimal breast shaping was performed in 2 ways. Mostly the abdominal flap was positioned horizontally, placing zone 2 medially. A contralateral flap was preferred because this positioned the superficial inferior epigastric vein cranially, facilitating venous connection to the cephalic vein if needed. Another way of breast shaping was achieved by positioning the flap vertically with zone 2 inferiorly, achieving a greater vertical skin height for larger ptotic breasts.

Patients wore long intraoperative pressure stockings and received subcutaneous low-molecular-weight heparin from the day before surgery until discharge. Patients received 40 mg of acetylsalicylic acid from the first day after surgery for 6 weeks.

Measures

Medical data

All patient data were obtained from a structured database in which patient characteristics, medical history, surgical data, and complications had been collected prospectively after informed consent of all patients in concordance with the ethical guidelines of the institutional clinical research committee.

Complications

Perioperative risk factors and complications were evaluated for the entire group. Complications were divided chronologically, in acute (< 72 hours), early (72 hours to 6 weeks), and late (> 6 weeks), as well as to location, in DIEP flap, abdominal, and breast skin flap (post subcutaneous mastectomy) complications. Systemic complications were also evaluated.

Statistical analysis and learning curve analysis

Data were analysed as frequencies and percentages or means and ranges. To detect possible differences between groups, Pearson χ^2, Fisher exact test, and Mann-Whitney *U* tests were used. Complication data were analysed to assess the learning curve. DIEP flap or abdominal complications were compared in chronologic order between patients. Furthermore, a linear-by-linear association between chronologic groups of patients or

DIEP flaps was performed. Two-tailed probabilities < 0.05 were accepted as statistically significant. Statistical analysis was performed using SPSS version 11.0 software (SPSS Inc, Chicago, IL).

RESULTS

Intraoperative details

Detailed information on intraoperative details is shown in Table 2. DIEP flaps could be raised 159 times (90.9%) on 1 to 4 perforators (1.6 ± 0.7, mean ± SD). In the remaining flaps, no DIEP flaps were harvested, because of venous outflow concerns of individual perforators.

Table 2 | Intraoperative details of 175 autologous tissue breast reconstructions between February 2002 and February 2006.

Autologous tissue breast reconstructions (n; %)		
DIEP flap	159	90.9
Muscle-sparing TRAM flap	13	7.4
TRAM flap	3	1.7
Flap weights in g (SD; range)		
Mean total abdominal flap weight	1396	635; 291 – 4000
Mean flap weight used for breast	721	247; 234 – 2250
Side of flap used (n; %)		
Contralateral	128	73.1
Ipsilateral	39	22.3
Unknown	8	4.6
Microsurgical anastomoses (n; %)		
Internal mammary vessels	174	99.4
Thoracodorsal vessels	1	0.6
Superficial venous system connection	5	2.9
Contralateral deep venous system connection	3	1.7
Operating times		
Flap dissection time in h (SD; range)	2.3	0.6;1.3 – 4.5
Microsurgery ischemia time in min (SD; range)	85	32; 35 – 240
Total operating room time unilateral DIEP in h (SD; range)	7.1	1.9; 4 – 14
Total operating room time bilateral DIEP in h (SD; range)	10.1	2.0; 6 – 16
Hospital admission time in days (SD; range)	10.1	7.3; 4 – 54

DIEP = deep inferior epigastric perforator flap
TRAM = transverse rectus abdominis musculocutaneous flap

Complications

In 76 patients (57%), no complications occurred at any time. In 55 patients (42%), 1 or more complications occurred at sometime during follow-up. In 26 patients (19.8%), these complications were treated conservatively. In 29 patients (22.1%), 1 or more operations were necessary to treat these complications at any time. Complications are presented below by anatomic location.

DIEP flap complications

In Table 3, detailed information on flap complications in relationship to time of occurrence is shown. Microsurgical revision rate was 4.0%, with a total flap failure rate of 0.6%. Partial flap failure rate was 8.6% (n = 15), which was solved by debridement, medial advancement, and direct closure in 6.8% (n = 12) and latissimus dorsi flap transposition in 1.8% (n = 3; Table 4). Fat necrosis, which was defined as a palpable lump with a diameter larger than 1 cm after 12 months, was recorded in 10 of 130 flaps (7.7%) that had a follow-up time of at least 1 year (Table 3).

Table 3 | DIEP flap complications in 175 breast reconstructions related to time of occurrence.

	< 72 hours		72 hours – 6 weeks		> 6 weeks – 1 year	
Total	**n**	**%**	**n**	**%**	**n**	**%**
Major (surgical)	13	7.4	4	2.2	–	–
Minor (conservative)	9	5.1	6	3.4	–	–
Arterial insufficiency*	2	1.1	–	–	–	–
Venous insufficiency*	4	2.2	–	–	–	–
Combined insufficiency*	1	0.6	–	–	–	–
Hematoma	6	3.4	–	–	–	–
(Partial) necrosis zone 2**	9	5.1	4	2.2	–	–
(Partial) necrosis other zones	–	–	2	1.1	–	–
Total flap necrosis	–	–	1	0.6	–	–
Seroma	–	–	1	0.6	–	–
Wound dehiscence	–	–	2	1.1	–	–
Fat necrosis	–	–	–	–	10	7.7***

* Due to microvascular occlusion requiring microsurgical revision.

** In all cases due to venous congestion.

*** One hundred thirty flaps flaps available with at least 1-year follow-up.

Table 4 | Amount of DIEP flap necrosis of 175 flaps.

Necrosis area of flap	n	%
< 10%	10	5.7
10% – 20%	2	1.1
20% – 30%	–	–
30% – 50%	3	1.8
100%	1	0.6

Abdominal complications

In Table 5, detailed information on abdominal complications in relationship to time of occurrence is shown. Most complications (67.7%) could be managed conservatively. Surgical revision within 6 weeks was needed in 6 patients with significant abdominal wound dehiscence, skin necrosis, or an abscess. Surgical revision for late functional complaints was needed in 3 (2.3%) of 7 patients with evident abdominal bulging requiring nonresorbable mesh reinforcement of the abdominal wall, with a satisfactory functional outcome.

Table 5 | Abdominal complications in 131 DIEP flap breast reconstruction patients related to time of occurrence.

	< 72 hours		72 hours – 6 weeks		> 6 weeks – 1 year	
Total	**n**	**%**	**n**	**%**	**n**	**%**
Major (surgical)	–	–	7	5.3	3	2.3
Minor (conservative)	1	0.8	16	12.2	10	7.6
Abscess	–	–	1*	0.8	–	–
Hematoma	1	0.8	1	0.8	–	–
Skin necrosis	–	–	5**	3.8	–	–
Dehiscence	–	–	16***	12.2	–	–
Bulging	–	–	–	–	4	3.1
Herniation	–	–	–	–	3****	2.3
Hypertrophic scarring	–	–	–	–	6	4.5

* One required surgical revision.

** Two required surgical revision.

*** Four required surgical revision.

**** Three required surgical revision.

Subcutaneous mastectomy skin envelope complications

All 8 patients with thin skin flaps with simultaneous skin resection with a Wise-type pattern during reconstruction had complications. Four patients needed revisional surgery. No relationship between smoking and skin-flap complications was found.

Systemic complications

Five patients (3.8%) developed a pulmonary embolism, and 1 patient presented with a deep venous thrombosis. These patients had all received a bilateral breast reconstruction, which means that 11% of 44 patients with bilateral breast reconstruction developed a pulmonary embolism.

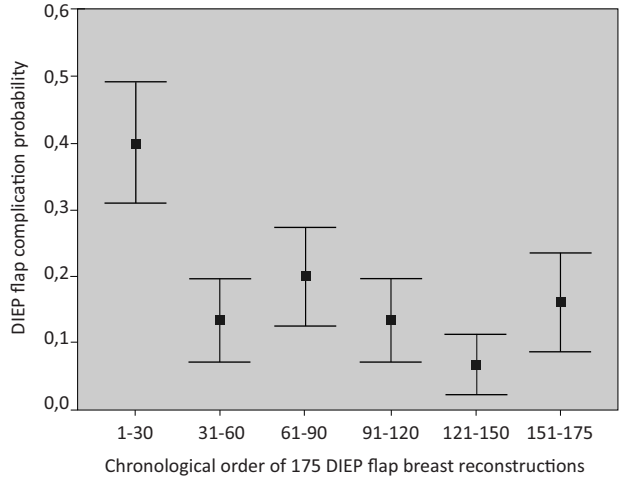
Analysis of risk factors and complications

No significant relationships between smoking, diabetes, hypertension, excessive BMI (> 30 kg/m^2), pregnancy, previous radiotherapy, previous abdominal operations, intraoperative venous insufficiency requiring additional venous anastomoses, excessive flap weight, ischemia time (> mean + 2SD), or early flap revision, and DIEP flap complications were found (data not shown). There was a trend, however, indicating that smoking and diabetes had a negative effect on DIEP flap complications (27% versus 16% and 43% versus 17%, respectively; Fisher exact test tests, $p < 0.233$ and $p < 0.107$). Statistically significant relationships between diabetes (60% versus 17%; Fisher exact test, $p = 0.043$), hypertension (36.8% versus 15%; Fisher exact test, $p = 0.048$), and the occurrence of abdominal complications were found. No other statistically significant differences between risk factors and abdominal complications were found.

Analysis of the learning curve

Comparison of DIEP flap complications between subsequent chronologic groups revealed a significant reduction of complications in DIEP flaps that were performed later in the series as indicated by their chronologic number (92 versus 70; Mann-Whitney *U* test, $p < 0.025$). The same was true for abdominal complications (71 versus 43; Mann-Whitney *U* test, $p < 0.001$). Linear-by-linear association between 6 chronologic groups of 30 consecutive DIEP flaps showed a significant decrease in DIEP flap complications, indicating a cut-off point after the first 30 DIEP flaps (40% complications in the first 30 DIEP flaps versus 13.8% complications in flaps 31 to 175, $p < 0.012$; Figure 1). The same was true for abdominal complications, but without clear cut-off point ($p < 0.001$, data not shown).

Figure 1 | Chronologic order of DIEP flaps performed in relation to the DIEP flap complication probability. Error bars represent one standard error from mean.



DISCUSSION

The purpose of this study was to evaluate DIEP flap breast reconstruction by critical assessment of intra- and postoperative problems in 175 consecutive breast reconstructions with autologous abdominal free flaps. Furthermore, relationships between patient characteristics and surgical outcome were evaluated.

Evaluation of the learning curve was of great personal interest but has been explored by others also.[3,4] Early experiences from our first 50 breast reconstructions indicated that venous congestion of zone 2 was a returning problem.[5] More liberal zone 2 excision has shown to benefit this issue, as clearly indicated by the highly significant cut-off point of DIEP flap complications after the first 30 flaps.

Preoperative and intraoperative findings with handheld Doppler ultrasound and/or colour Duplex flow did often not match. Recent reports on multidetector row CT scanning indicate better perforator detection.[6] In the current series, we were able to dissect DIEP flaps in 90.9%. In contrast to our findings, selection criteria for raising DIEP flaps have been proposed on the basis of patient comorbidities.[7] Reports on DIEP flap breast reconstruction disregard those cases where perforators are insufficient, which in our opinion is the most important measure for DIEP flap harvest. Obviously, personal experience and confidence will influence perforator selection. In our experience, however, it is impossible to raise a viable DIEP flap on every occasion. We advocate conversion to (muscle-sparing) TRAM flap in case of borderline sufficient perforators to achieve low failure rates for these aesthetic reconstructive procedures.

Successful aesthetic outcome of DIEP flap breast reconstruction is dependent on proper breast shaping. The use of internal mammary vessels as recipient vessels gives great freedom of movement for the flap. Also, the internal mammary artery has a greater flow rate than the thoracodorsal artery.[8] To achieve a natural IMF in secondary

cases, all skin between a line 2 cm above the contralateral IMF and the mastectomy scar is discarded. After abdominal closure, this new IMF will move slightly further downward than the nonoperated IMF and become a symmetrical perfect IMF. The DIEP flap is inset horizontally, with the lesser reliable zone 2 medially. This is in contrast to previously advocated lateral positioning of zone 2.[4] The advantage of a medially positioned zone 2 is that the entire remaining flap can be advanced medially in case of limited partial flap necrosis to maintain medial upper-pole filling. A contralateral DIEP flap is preferred since an additional advantage of 180-degree rotation is that the superficial venous system is placed cranially for easier anastomosis to the cephalic vein, if needed. Venous drainage to the cephalic vein was used in 5 cases (2.9%), which is comparable to earlier reported 2.1%.[9]

Operating time and hospital stay is comparable to that in earlier reports.[10] In our experience, a unilateral DIEP flap breast reconstruction can be performed within 6 hours. Bilateral DIEP flap breast reconstructions are major procedures, taking on average 10 hours. In cases of difficult perforator harvest or insufficient venous outflow, a DIEP flap operation can take much longer. In the current series, unilateral operations of longer than 8 hours had significantly more flap complications (40.7% versus 19.6%; χ^2 test, $p = 0.041$).

Flap survival rate (99.4%) in the current group was considered excellent.[9-11] Partial flap necrosis was significantly unfavourable in the early study period (11/34 flaps, 32.3% versus 5/141 flaps, 3.5%; Fisher exact test, $p < 0,001$), due to too conservative resection of zones 2 and 4 in unilateral DIEP flaps as a result of limited experience. In all but 3 cases, this complication was solved by debridement, medial flap advancement, and direct closure. From this experience, we concluded, like others, that the original TRAM flap zone 1 to 4 classification does not hold up.[12] There seems to be a midline venous "divide," which regularly limits a substantial part of zone 2 to be used. This finding does not support earlier reported routine unproblematic use of all zones of an entire DIEP flap on 1 or more perforators in one zone.[13]

Fat necrosis is an important issue in breast reconstruction, and patients need to be informed of this preoperatively, as it otherwise will generate anxiety. Fat necrosis rates in DIEP flaps (18%) have been reported to be far lower than those after pedicled TRAM flaps (59%).[14] It is important to realize that detection of fat necrosis can be investigator biased.[15] On physical examination, we found "solid" fat tissue (diameter > 1 cm) following breast reconstruction in approximately 14% of all flaps after 3 months. These solid areas disappeared in all but 7.7% of flaps with 12 months' follow-up.

The main reason for DIEP flap dissection is donor-site morbidity reduction. This difference in morbidity has been studied, with different outcomes.[16-18] In DIEP flap dissection, a motor nerve branch can be damaged. Still, we feel that damage to the rectus abdominis muscle during DIEP flap harvesting is less compared with (muscle-sparing) TRAM flap dissection. Critical analysis of abdominal donor-site morbidity showed bulging in 5.3%, which is in line with previous reports of DIEP flap morbidity and lower than (muscle-sparing) TRAM flap morbidity.[14,17,18]

Short-term abdominal wound healing complications were lower than those reported for abdominoplasty.[19,20] This may be explained by the limited undermining performed in our group.[20] A positive correlation between diabetes, hypertension, and abdominal complications was found comparable to previous reports in regular abdominoplasties.[19]

Complications of the skin envelope after subcutaneous mastectomy through periareolar incisions were minimal. Statistically significant occurrence of skin necrosis was seen in all 8 patients where a skin resection with a Wise pattern was performed. This method recently has been proposed as a safe and useful technique in these cases.[21] We feel that combination of thin skin flaps for safe oncologic treatment and increased tension occurring in a mastopexy or breast reduction in the presence of wide skin undermining with the T-shaped scar needed for skin envelope reduction contributes to the higher risk of wound dehiscence and skin flap necrosis. Our current strategy is to perform skin reduction by periareolar incision. No skin flap necrosis has occurred in any of the other 14 patient operations performed in this fashion.

The most threatening complications in this series were pulmonary embolisms in 5 of 44 patients (11%), who all underwent bilateral breast reconstruction. These figures are higher than those in literature for abdominoplasty combined with other procedures[22] but are difficult to interpret because of the small series. All patients survived. None had increased risk factors. All patients were adequately managed according to strict perioperative antithrombotic guidelines, consisting of low-molecular-weight heparin from 1 day before operation till discharge from the hospital, in combination with compression stockings. Pulmonary embolism after DIEP flap reconstruction can present in a masked fashion because these patients usually have received abundant fluids to maintain blood pressure for good flap circulation. Slight shortness of breath is therefore often blamed on hyperhydration or compression atelectasis with or without pneumonia. In our series, only patients with progressive shortness of breath and decreased blood oxygen saturation values had spiral CT scans proving pulmonary embolism. When in doubt, a spiral CT scan should be made to diagnose a possible lung embolism. We have now added pneumatic compression stockings for prevention in bilateral DIEP flap breast reconstructions.

CONCLUSION

DIEP flap breast reconstruction is an excellent method, with limited donor-site morbidity. In our series, a definite learning curve was reflected by a larger number of complications in the beginning of our series. After the initial learning curve, complications decreased significantly, although the occasional DIEP flap breast reconstruction remains very tedious due to its anatomy.

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Microsurgical breast reconstruction: how to stay and get out of trouble

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J Plast Reconstr Aesthet Surg, submitted.

ABSTRACT

Background

Multiple perioperative and intraoperative decisions involving flap choice, donor and recipient vessel selection, and early recognition and management of complications can determine the success or failure of microsurgical breast reconstruction. The purpose of this study was to retrospectively review a single surgeon's experience with microsurgical breast reconstruction to develop decision-making algorithms to increase the rate of successful outcomes.

Methods

We reviewed a prospectively maintained database of all microsurgical breast reconstructions performed by a single surgeon. Patient demographics, procedural characteristics, and intraoperative and early postoperative (< 6 weeks) complications were examined. In addition, decisions regarding flap choice, donor and recipient vessel selection, and management of complications were analysed to identify trends associated with successful microsurgical breast reconstruction.

Results

Since 2002, 406 microsurgical breast reconstructions were performed. Deep inferior epigastric perforator (DIEP) flaps comprised 88% (n = 359) of all flaps, while muscle-sparing and fascial-sparing transverse rectus abdominis musculocutaneous (TRAM) flaps were harvested in 11% (n = 44) and 1% (n = 3), respectively. One-hundred-seventy-one (48%) DIEP flaps used a single perforator and 188 (52%) had multiple perforators; the average number of perforators per DIEP flap was 2. The internal mammary artery and vein were used as the recipient vessels for 99% (n = 403) of flaps. Additional venous drainage was required for 11% (n = 48) of flaps. Partial flap failure occurred in 9 flaps, while total flap failure occurred in 2 flaps.

Conclusions

After a review of 406 microsurgical breast reconstructions, we propose several practical algorithms for decision-making in microsurgical breast reconstruction to increase success rates and avoid potentially disastrous complications. Proper patient selection, flap choice, donor and recipient vessel selection, and management of complications form the foundation for successful microsurgical breast reconstruction.

INTRODUCTION

Advances in both our understanding of anatomy and microsurgical technique have made high success rates in microsurgical breast reconstruction a reality.[1-3] Although significant literature exists in both of these areas, there are very few descriptions of decision-making in microsurgical breast reconstruction that help to avoid potentially disastrous outcomes.[4,5]

Early experience with the first 175 institutional deep inferior epigastric perforator (DIEP) flap breast reconstructions was previously reported through the associated learning curve.[6] It was suggested to require approximately 30 flaps to acquire sufficient experience for the complication rate to plateau. Due to anatomic variation and technical complexity associated with microsurgical breast reconstruction, even more experience is required to develop a decision-making process that results in successful outcomes. The senior author's consecutive 406 free flap breast reconstructions were analysed to develop surgical algorithms. Multiple perioperative and intraoperative decisions, including proper flap choice, appropriate donor and recipient vessel selection, and recognizing and managing complications, can ultimately make the difference between success and failure. In this article, we examine how these factors have come into play in our experience and attempt to provide useful algorithms to stay and get out of trouble when performing microsurgical abdominal flap breast reconstruction.

PATIENTS AND METHODS

The senior author has kept a prospectively maintained database of patients undergoing microsurgical breast reconstruction, first at Erasmus MC, Rotterdam, Netherlands (2002-2007), and later at University Health Network, Toronto, Canada (2007-present). A review of this database for all microsurgical breast reconstructions performed by a single surgeon (SOPH) was performed. Patient demographics, procedural characteristics, and intraoperative and early postoperative (< 6 weeks) complications were examined. In addition, decisions regarding flap choice, donor and recipient vessel selection, and complications and their management were analysed to identify trends associated with successful microsurgical breast reconstruction.

Minimum postoperative follow-up was 3 months. The principles outlined in the Declaration of Helsinki were followed during the completion of this study. Institutional ethical review board approval was acquired for this study.

RESULTS

Between January 2002 and March 2011, 285 patients underwent 406 microsurgical breast reconstructions by a single surgeon (SOPH) (Table 1). From January 2002 to September 2007, 143 patients were treated at Erasmus MC, Rotterdam, Netherlands and from December 2007 to March 2011, 142 patients were treated at University Health Network, Toronto, Canada. The average patient age at surgery was 49 years (range 22 to 73 years). Twelve percent of patients were smokers and 22% were obese (BMI > 30 kg/m^2). Ninety-

eight percent of patients underwent therapeutic or prophylactic mastectomy for breast cancer. Unilateral breast reconstruction was performed in 58% of patients, while 42% underwent bilateral breast reconstruction.

Table 1 | Patient demographics and procedural characteristics of 285 patients.

Average age in years (range)	**49 (22-73)**
Total number of flaps	**406**
Unilateral	164
Bilateral	242
Timing of reconstruction	
Immediate	129
Delayed	209
Combination (bilateral cases)	68
Indication for mastectomy	
Breast cancer	226
Prophylactic (i.e., BRCA positive, high risk)	52
Other (i.e., chronic mastitis, chronic infection, lymphangioma, capsular contracture after breast augmentation)	7

Immediate breast reconstruction was performed in 32%, 51% received delayed breast reconstructions, and 17% were combinations of immediate and delayed reconstructions in bilateral cases.

Intraoperative technical details including flap choice, donor and recipient vessel selection, along with microsurgical complications, and flap failure are provided in Table 2. DIEP flaps comprised 88% (n = 359) of all flaps, while muscle-sparing (MS) and fascial-sparing (FS) transverse rectus abdominis musculocutaneous (TRAM) flaps comprised 11% (n = 44) and 1% (n = 3), respectively. Of all DIEP flaps, 171 (48%) had a single perforator and 188 (52%) had multiple perforators. The average number of perforators per DIEP flap was 2. The internal mammary artery (IMA) and vein (IMV) were used as the recipient vessels for 99% (n = 403) of flaps while the thoracodorsal artery (TDA) and vein (TDV) were used twice (1%). In one case, the IMA was used along with the cephalic vein (CV). Additional venous drainage was deemed necessary for 11% (n = 48) of flaps. Anastomosis of a second concomitant vein was most commonly performed (n = 34) followed by anastomosis of the superficial inferior epigastric vein (SIEV) on the congested side (n = 10). For 3 flaps, the contralateral deep venous system was added and once a lateral row vein of the ipsilateral deep system was used.

Reexploration of the anastomosis was performed in 7% of cases (n = 30). Flap related hematoma was the most common indication (n = 20); 10 flaps were reexplored due to venous (n = 9) and arterial (n = 1) insufficiency.

Partial flap failure occurred in 9 flaps and was corrected with debridement combined with a local advancement flap (n = 4), a latissimus dorsi musculocutaneous flap (n = 3), or primary closure (n = 2). Total flap failure (n = 2) was revised with early (< 7 days following the initial surgery) radical debridement, followed by tissue expander placement (n = 1) and superior gluteal artery perforator (SGAP) flap reconstruction (n = 1).

Table 2 | Intraoperative technical details and flap failure.

DIEP (number of flaps)	**359**
Average number of perforators per flap (range)	2 (1-5)
1 perforator	171
2 or more perforators	188
MS-TRAM (number of flaps)	**44**
FS-TRAM (number of flaps)	**3**
Microsurgical anastomoses (number of flaps)	
Internal mammary artery and vein	403
Thoracodorsal artery and vein	2
Internal mammary artery and cephalic vein	1
Additional venous drainage (number of flaps)	
SIEV	10
Additional vena comitante	34
Contralateral deep venous system	3
Ipsilateral lateral row	1
Microsurgical revision (number of flaps)	
Arterial insufficiency	1
Venous insufficiency	9
Hematoma	20
Venous congestion (number of flaps)	**21**
Partial flap failure (number of flaps)	**9**
Primary closure	2
Partial excision and local advancement flap	4
Latissimus dorsi musculocutaneous flap	3
Total flap failure (number of flaps)	**2**
Tissue expander/implant	1
SGAP free flap	1

Complications encountered in this series are listed in Table 3. Venous congestion (7.4%) and hematoma (7.0%) were the most common complications.

Table 3 | Complications in 285 microsurgical breast reconstruction patients.

Complications	n (%)
Hematoma	20 (7.0)
Venous congestion	21 (7.4)
Delayed wound healing – breast	14 (4.9)
Delayed wound healing – abdomen	9 (3.2)
Wound infection – breast	3 (1.1)
Wound infection – abdomen	4 (1.4)
Fat necrosis – breast	14 (4.9)
Abdominal hernia	6 (2.1)
Partial flap loss	9 (3.2)
Total flap loss	2 (0.8)
Pulmonary embolism	7 (2.5)

DISCUSSION

Multiple perioperative and intraoperative decisions can make the difference between success and failure in microsurgical abdominal flap breast reconstruction. The purpose of this study was to assess a single surgeon's experience of 406 consecutive free flap breast reconstructions to develop perioperative decision algorithms on how to stay and get out of trouble when performing microsurgical abdominal flap breast reconstruction. Successful microsurgical breast reconstruction depends on proper decision-making regarding patient selection, flap choice, donor and recipient vessel selection, and complications and their management.

Patient selection

Several studies have outlined patient factors that are unfavorable for microsurgical breast reconstruction including obesity (BMI > 30 kg/m^2) and smoking.[7-9] In this series, 22% of patients were obese and 12% were smokers. Even though neither of these factors were significantly associated with flap failure, patients should be informed that they have an increased risks of delayed wound healing, fat necrosis, and pulmonary embolism. These observations have been noted in previous studies.[10,11]

The implications of coagulopathy in microsurgery have been described.[12,13] A history of coagulopathy should be inquired after. In this series, one of the patients who suffered total flap failure was diagnosed with essential thrombocytosis with a platelet count of > 1400.

Preoperative computed tomography angiography

Preoperative imaging of abdominal wall anatomy including perforator vessel mapping has been well described.[14] Several modalities are used including colour duplex sonography, computed tomography angio-graphy (CTA), and magnetic resonance angiography (MRA). In the last 142 patients in this study, preoperative CTA of the abdomen was performed. This was found to be a useful tool for planning surgery, as it provided information about the number, size, location, and intramuscular trajectory of perforators. Knowledge of the anatomy may expedite dissection and reduce operation times.[15-17] CTA is less useful for providing information regarding venous anatomy which forms the basis for vessel selection in our practice; the adequacy of veins still needs to be additionally assessed at time of surgery.

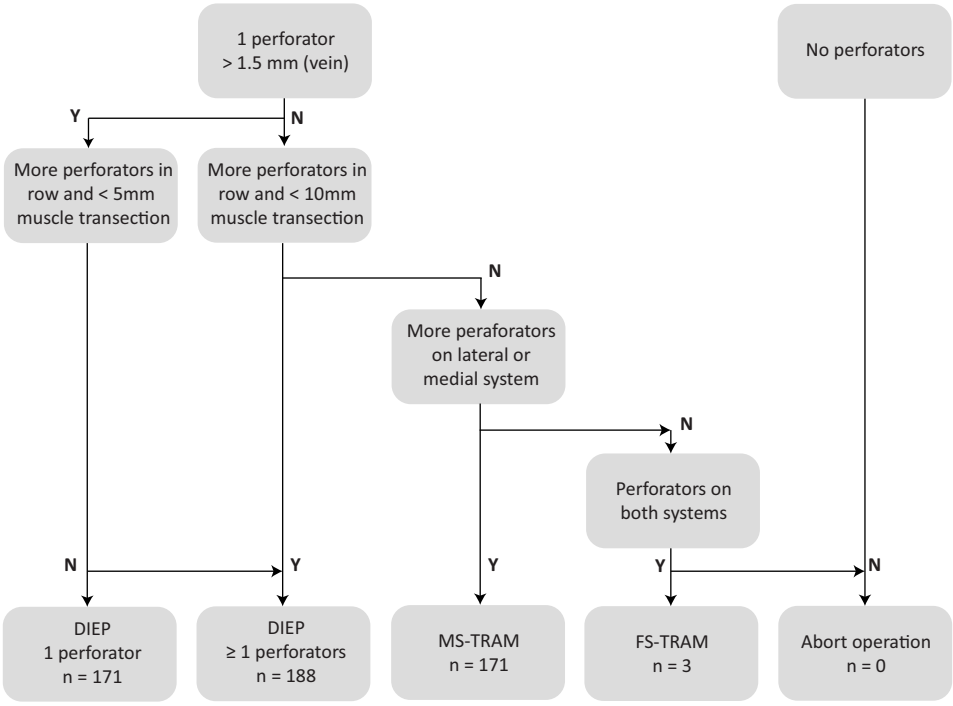
Flap selection

Significant advances in anatomical and technical refinements pertaining to microsurgical breast reconstruction have been made, but very little has been described regarding flap selection. There are several options for abdominal based microsurgical breast reconstruction: superficial inferior epigastric artery (SIEA), single versus multiple perforators DIEP, MS-TRAM, FS-TRAM. In this series, the DIEP flap was performed most commonly (88%), with MS- and FS-TRAM flaps being performed less commonly. The senior

author did not favor SIEA flaps in the few cases that were judged to have a sufficiently large pedicle diameter. Forty-eight percent of DIEP flaps were based on a single perforator while 52% required multiple perforators; the average number of perforators per flap was 2.

Based on our experience, an algorithm was developed for flap selection (Figure 1). The decision to perform a single perforator DIEP flap is made based on the vein diameter as opposed to that of the artery. A single perforator is chosen if the vein is 1.5 mm or larger. The size of the artery is not considered in this decision. If more perforators are in a row and less than 1 cm of muscle and no nerve have to be transected, a 2nd or 3rd perforator is added, even if the 1st perforator is judged adequate. Two or more perforators in a row are always used when individual veins are smaller than 1.5 mm or when in doubt over perforator size. Microvascular clamps can be applied to individual perforators or combinations of perforators to test flap circulation. When flap circulation is judged insufficient and dissection of multiple perforators requires resection of more than 1 cm of muscle, a MS-TRAM flap is dissected. A FS-TRAM flap is raised when both medial and lateral row perforators are required for adequate flap circulation resulting in significant rectus muscle transsection.

Figure 1 | Algorithm for flap selection**.**



Y = yes, N = no, DIEP = deep inferior epigastric perforator flap, MS-TRAM = muscle-sparing transverse rectus abdominis musculocutaneous flap, FS-TRAM = fascia-sparing transverse rectus abdominis musculocutaneous flap.

Many authors have described anatomical observations of intraflap circulation and these findings should be taken into account when deciding what portions of the flap will receive adequate perfusion.[1,3,18] In general, Hartrampf zones 1 and 3 are always kept for unilateral breast reconstruction, while zone 2 is rarely used and zone 4 is entirely discarded.[19] For bilateral breast reconstruction, two hemi-abdominal flaps are dissected (zones 1 and 3 for both flaps). In this series, most problems with partial flap failure and persistent venous congestion were encountered when a flap included a significant part of zone 2. If a large flap containing a significant proportion of the contralateral abdominal tissue is required, additional venous drainage or a double-pedicled DIEP flap must be considered.[20,21]

Recipient vessel selection

The internal mammary (IM) vessels are preferred as recipient vessels. The advantages of their location, flow, and calibre have shifted preference away from the thoracodorsal vessels.[22,23] A particular advantage of these vessels is their superomedial location, which facilitates breast mound creation. When the best-perfused zones of the flap are positioned medially, the important medial contour of the breast is least affected in case of inadequate perfusion and fat necrosis of the lateral zones. In the event that the IM vessels are unavailable or unsuitable, the thoracodorsal (TD) vessels are attempted. The serratus branch of the TD vessels or the thoracoacromial vessels are other alternatives, preserving the pedicle to the latissimus dorsi muscle for the future. In this series, the IM vessels were used for 99% of flaps. In one case, occlusion of the IMA warranted anastomosis to the TDA and TDV. In another case, venous anastomosis was performed to the CV as the IMV was judged too small.

Intraoperative venous congestion

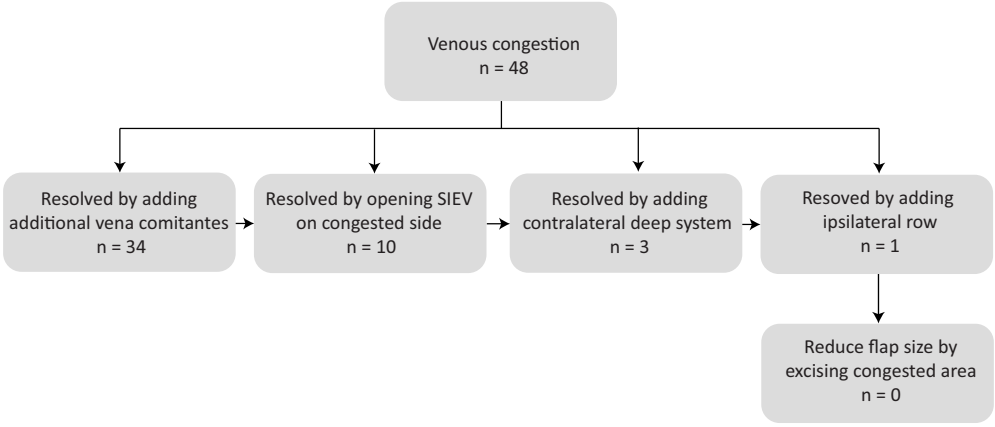
Additional venous drainage was required for 11% (n = 48) of flaps. The use of two venous anastomoses has been shown to result in a significant reduction of the number of cases of venous congestion,[24] but in our experience this is only required in a minority of cases. An algorithm for establishing additional venous drainage has been developed based on this experience (Figure 2). Given the proximity, anastomosis of a second concomitant vein is the first choice for additional venous drainage and was most commonly performed (n = 34). This vein is usually anastomosed to the second concomitant IMV. The senior author does not commonly use the distal stump of the IMV as previously described,[25] since venous valves impeding possible venous outflow are present in the retrograde IMV.[26] The SIEV is the second choice for additional venous drainage if the second concomitant vein does not give any relief and was used for 10 flaps.[27] In most instances, a length of approximately 5 cm can be dissected during flap harvest and this allows for it to be anastomosed to either a side branch of the deep inferior epigastric vein (main pedicle) or to the CV that has been distally transected and transposed into the field (cephalic turnover). If both the concomitant vein and SIEV cannot be used, the contralateral deep venous system or an ipsilateral lateral row vein are options for additional venous drainage; these were used for 4 flaps.

Postoperative venous congestion

Management of postoperative venous congestion depends largely on intraoperative findings. If no problems were encountered during surgery and venous congestion develops postoperatively, exploration in the operating room is requisite to locate the cause (e.g., compression of the pedicle, venous thrombosis). In the event of inadequate venous outflow, additional venous drainage should be established as outlined previously. Salvage procedures for venous compromised DIEP flaps are better performed intraoperatively rather than postoperatively to prevent further complications.[28]

If problems with venous congestion were encountered during surgery and options for establishing additional venous drainage were exhausted, then only conservative measures or debridement remain.

Figure 2 | Algorithm for treating venous congestion.



Anastomosis to: 1st option: side branch of pedicle, 2nd option: large perforator from IMV, 3rd option: cephalic vein, 4th option: retrograde to distal IMV

SIEV = superficial inferior epigastric vein

Microsurgical revision

Reoperation in the early postoperative period is typically for reexploration with possible revision of the microsurgical anastomosis. The most common indication for reexploration was flap related hematoma (n = 20). Suspicion of hematoma should prompt a return to the operating room to prevent further bleeding and compression of the pedicle. A systematic approach should be used to identify the source of bleeding; inspection should include the anastomoses for arterial and/or venous thrombosis, major vessels and branches including the SIEV and the superior end of the DIEP vessels for a non-ligated vessel, and the flap and surrounding recipient wound bed. In case of longer standing vascular thrombosis,

intravascular heparin or intraflap tissue plasminogen activator may be required to resolve thrombi and prevent further thrombosis at the anastomosis.[29-31] Tissue plasminogen activator often results in further excessive bleeding and hematoma, which should be assessed carefully in the postoperative course.

Management of complications

Systemic complications

Venous thromboembolism. The most common systemic complication in this series was pulmonary embolism (2.5%). The importance of thromboprophylaxis in plastic surgery has received considerable attention in recent years.[32-34] Most patients undergoing microsurgical breast reconstruction fall into the very high-risk group with currently used risk assessment models.[35-37] Standard thromboprophylaxis consisted of low-molecular-weight heparin initiated preoperatively and continued postoperatively in combination with elastic compression stockings.

Pulmonary embolism occurred more frequently in the earlier part of this series. At the time, patients were placed on bed rest for 3 days postoperatively. As this period of immobilization was likely to be a strong contributing factor, we began practicing early ambulation and introduced pneumatic compression stockings for bilateral cases. Since these changes to protocol, no patients have experienced symptomatic pulmonary embolism.

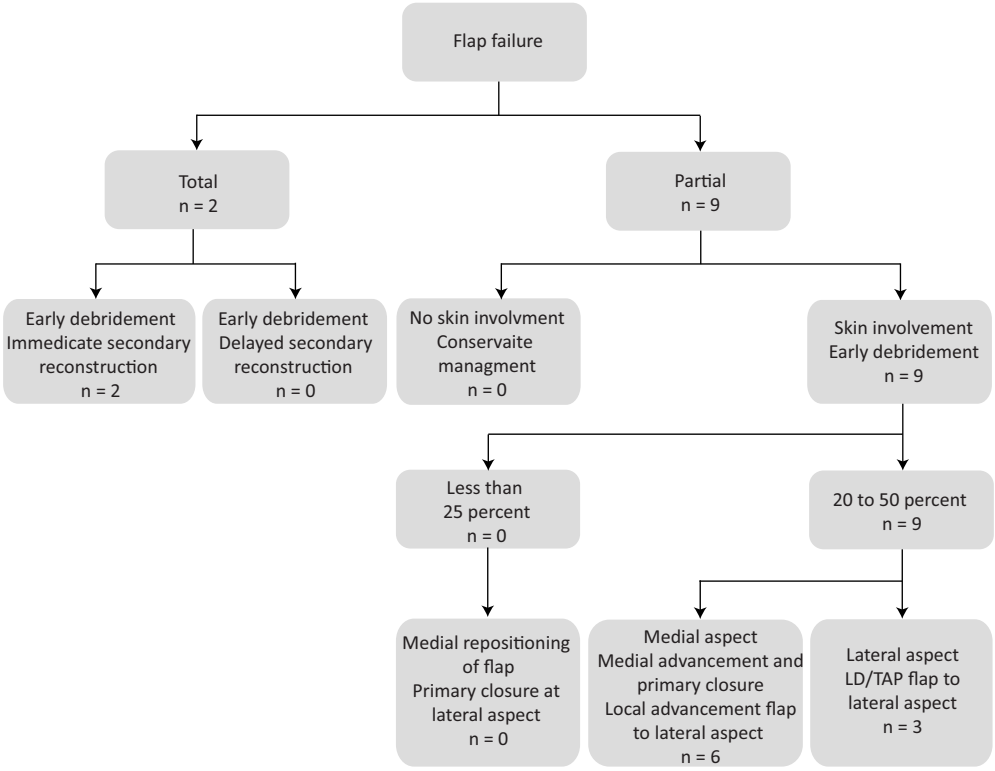
Recipient site complications

Mastectomy skin flap necrosis. Necrosis of mastectomy skin flaps is not common but does occur.[38] If mastectomy skin flap quality is poor at the time of surgery, resection of this skin and preservation of more skin from the flap helps to avoid significant areas of delayed wound healing secondary to mastectomy skin flap necrosis. An alternate approach is to bury the skin of the free flap and return for inset after the questionable areas have declared themselves.[39] This approach, however, obligates another operation. Mastectomy skin flap necrosis should be managed conservatively with wound care and typically heals by secondary intention. If there are large areas of necrosis, skin grafting may be required to prevent deformity secondary to wound contracture.

Partial and total flap failure. Partial flap failure occurred in 9 patients and is typically secondary to inadequate venous drainage (Figure 3). The presentation may vary from fat necrosis to more marked necrotic changes of larger areas of skin and deeper flap tissues. When less than 25% of the flap is affected, early (4 to 7 days postoperatively) excision and repositioning of the flap is suggested to avoid wound contraction. Partial failure of the medial aspect of the flap allows for the flap to be medially advanced, thus preserving medial fullness, with primary closure of the lateral aspect or use of a local advancement flap. This strategy was used in 6 patients. With 25-50% of the flap affected, early radical debridement with salvage reconstruction is recommended. Pedicled superior epigastric artery perforator (SEAP) flaps can be raised to cover medial defects.[40] Loss of the lateral aspect of the flap is typically addressed using a latissimus dorsi musculocutaneous or thoracodorsal artery perforator flap. Salvage reconstruction using this technique was used

in 3 patients. If the DIEP flap skin is not involved but larger areas of fat necrosis become evident, a conservative approach is preferred. Areas of fat necrosis are allowed to demarcate and excision is preferentially delayed until at least 1 year after the initial reconstruction to allow for healing and for the size of these areas to decrease. Ultimately, volume loss may need to be corrected with addition of a breast implant, autologous fat grafting, or new autologous tissue flap.

Figure 3 | Algorithm for treating partial and total flap failure.



LD = latissimus dorsi musculocutaneous flap, TAP = thoracodorsal artery perforator flap

Total flap failure has been rare. In this series, 2 patients suffered total flap failure. Generally, the options for breast reconstruction in this situation are similar to before the failed reconstruction, with the obvious exception of abdominal flap breast reconstruction. In addition, the recipient vessel may no longer be usable. Timing of reconstruction is another challenge. After immediate breast reconstruction, there is generally adequate mastectomy skin to allow for wound closure and delayed reconstruction. However, performing another microsurgical breast reconstruction at the time of flap debridement or insertion of a tissue expander allows maximal utilization of the mastectomy skin flaps; delaying reconstruction

sacrifices the redundant skin envelope. With delayed breast reconstruction, there is not enough skin for primary wound closure. Salvage breast reconstruction at the time of debridement of the failed flap should be strongly considered to avoid skin grafting. In this series, one patient with total flap failure after immediate DIEP flap reconstruction was diagnosed with essential thrombocytosis as previously described. With this significant co-morbidity, a decision was made to forgo any further microsurgical breast reconstruction. A tissue expander was inserted at the time of flap debridement followed by implant-based reconstruction. The other patient with total flap failure underwent DIEP flap reconstruction complicated by significant and uncorrectable venous congestion. She underwent early radical debridement combined with SGAP free flap reconstruction without any further flap complications, but she suffered major donor-site complications on her buttock.

Donor-site complications

Early donor-site complications typically include abdominal wound dehiscence, skin flap necrosis, and delayed wound healing. Ultimately, delayed wound healing occurred in 3.2% of patients. In most cases, it was managed conservatively with wound care and healing by secondary intention. A significant area of abdominal skin necrosis may require debridement. With a large abdominal wound, we have found VAC therapy to be a useful addition as it can speed up healing by secondary intention and obviate the need for skin grafting. In the rare instance that a skin graft is required, serial excision can be used to remove the grafted area later. Experience gained in this series has led to an approach for abdominal donor-site closure that involves very limited undermining of the abdominal skin flap, intraoperative tissue expansion with the use of towel clamps, and closure of the abdominal wound as soon as possible to prevent desiccation of these tissues.

CONCLUSION

After a review of 406 microsurgical breast reconstructions, we propose several practical algorithms for decision-making in microsurgical breast reconstruction to increase success and avoid potentially disastrous complications. Proper decisions on patient selection, flap choice, donor and recipient vessel selection, and management of complications form the foundation for successful microsurgical breast reconstruction.

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The pleasing end result after DIEP flap breast reconstruction: a review of additional operations

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ABSTRACT

Background

Breast reconstruction with deep inferior epigastric perforator (DIEP) flaps is typically a 3-stage procedure, but additional operations may be required to deal with complications or to improve the aesthetic result. Purpose of this study was to evaluate the total number of operations needed after DIEP flap breast reconstruction to achieve a satisfactory end result for the patient.

Methods

From December 2002 until October 2006, 99 DIEP flap breast reconstructions obtained an end result in 72 patients. Data were collected in a structured database. Additional operations and complications were evaluated for the entire group. A study-specific questionnaire was used to evaluate patient satisfaction.

Results

The mean number of additional operations was 1.4 per patient. Patients with complications required more operations than patients without complications. Women who chose nipple reconstruction were younger than women who did not and were more likely to have had a primary or secondary than a tertiary reconstruction. The number of additional aesthetic operations was neither related to the occurrence of complications during the initial reconstruction, nor to patient satisfaction. Overall, patients were very satisfied with the end result.

Conclusions

Completion of DIEP flap breast reconstruction involved the initial reconstruction and an average of 1.4 additional operations. Patients were generally very satisfied with the end result.

INTRODUCTION

In the U.S.A. and western European countries the incidence of breast cancer is high. In The Netherlands the lifetime risk for women is around 11%.[1] Detection and treatment of breast cancer have improved over the past years leading to better survival rates and contributing to an increasing demand for breast reconstruction after mastectomy.

There are essentially three types of breast reconstruction, either using implant material, autologous tissue, or a combination of both. All techniques have their own place in the current practice of breast reconstruction. To allow patients to make a conscious decision, accurate patient education is of vital importance and should include positive as well as negative aspects, offering a truthful perspective of the entire reconstruction process. Realistic expectations lead to increased patient satisfaction.[2,3]

In our setting, the deep inferior epigastric perforator (DIEP) flap is the preferred method to supply autologous tissue for breast reconstruction. Advantages of this procedure have been reported previously.[4-9]

Regardless of type of breast reconstruction, three stages can be identified: breast mound and infra-mammary fold (IMF) creation, nipple reconstruction, and nipple areola complex (NAC) tattooing. Additional operations are sometimes necessary to deal with complications or to improve the aesthetic result. The total number of operations is an important aspect of the reconstruction process and should therefore be addressed.

Additional procedures after breast reconstructions have been evaluated previously, but specific information on (the number of) additional operations after DIEP flap breast reconstruction is limited.[10-12]

The purpose of this study was to evaluate the total number of operations needed after DIEP flap breast reconstruction to achieve an aesthetically pleasing end result, based on patient satisfaction, in order to improve patient information.

PATIENTS AND METHODS

Patient sample characteristics

Between February 2002 and October 2006, 204 consecutive DIEP flap breast reconstructions were performed in 155 patients. On October 1st 2006, patients with an end result were identified in our database. A completed breast reconstruction was defined as a breast with a reconstructed nipple. Patients were also included if they had declined additional operations one year after DIEP flap breast reconstruction or if they had undergone an additional operation but refrained from further surgery one year after the last operation. The first 24 patients (30 flaps) of our series were excluded, as we showed previously that these patients represented our learning curve.[13] Patients who had died during the follow-up period were also excluded.

Breast reconstruction protocol

Our DIEP flap protocol was described in detail previously.[13,14] Breast reconstruction was introduced to the patient as a 3- or 4-stage protocol. After the actual reconstruction of breast mound and IMF, additional aesthetic operations (such as nipple reconstruction) and finally NAC tattooing were offered to all patients. If appropriate, as many procedures as possible were performed in one additional operation. Mean time between operations was 8 months (range 2-15 months) and mean time between initial reconstruction and nipple reconstruction was 10 months (range 3-31 months). These long intervals were mainly caused by surgery waiting lists.

Measures

Patient satisfaction

A study-specific questionnaire was developed, based on questionnaires described in literature.[15,16] Nine questions measured patient satisfaction with the end result of DIEP flap breast reconstruction. Overall satisfaction was rated on a ten-point scale, ranging from 1 (extremely dissatisfied) to 10 (extremely satisfied). Specific satisfaction items were rated on a five-point Likert scale, ranging from Yes! (extreme satisfaction) to No! (extreme dissatisfaction). The self-report questionnaire was mailed to all patients who met the inclusion criteria and patients were requested to return it. Two weeks after mailing the questionnaire, non-responders were sent a reminder. One month later remaining non-responders were contacted by phone. No patients were lost to follow-up.

Medical data

All patient data were obtained retrospectively from a structured database in which patient characteristics, medical history, number of operations and types of procedures, and complications had been collected prospectively. Written informed consent was obtained from all patients and the study was conducted in concordance with the ethical guidelines of the institutional clinical research committee.

Definition of additional operations

In this study additional operations were defined as any surgical manipulation of the reconstructed breast, the contralateral breast, or the donor-site.[11] Nipple reconstruction, despite being an integral part of the breast reconstruction process, was also considered an additional operation. Adjustments to the contralateral breast aimed at improving symmetry were taken into account, those performed purely for functional reasons were not. NAC tattooing was not considered an operative procedure, and was therefore not part of the evaluation.

We focused primarily on operations aimed at improving aesthetic outcome of the breasts or donor-site, rather than on operations dealing directly with complications, such as partial flap loss or abdominal wound healing problems. The latter have been described in detail previously.[13]

Statistical analysis

The number of additional operations was studied in relationship to patient satisfaction, complications, and reconstruction characteristics. Distribution of patient satisfaction was skewed, requiring root transformation to obtain a normal distribution for further analysis. To detect possible differences between groups Chi-square tests and Fisher's exact tests were used for categorical variables. Differences between groups regarding continuous variables (such as age and satisfaction) were analysed with Student's *t*-tests and Mann-Whitney *U* tests. Given that women who had suffered complications or had refrained from additional operations may have had a different perspective when evaluating their end result, analyses were performed on the complete sample as well as on sub samples. Furthermore, linear regression analysis was performed with overall patient satisfaction as outcome variable. We adjusted for age and timing of reconstruction. Logistic regression analysis was used to evaluate the relationship between nipple reconstruction and age and timing of reconstruction. Two-tailed probabilities < 0.05 were accepted as statistically significant. Statistical analyses were performed using SPSS version 12.0 software (SPSS Inc, Chicago, Illinois).

RESULTS

Seventy-two patients with 99 completed DIEP flap breast reconstructions and a mean follow-up of 2.4 years were identified. Fifty-nine patients were included after nipple reconstruction, four after NAC tattooing without nipple reconstruction, and nine patients for declining all (n = 8) or any further (n = 1) additional operations. Primary, secondary, and tertiary reconstructions were included. Patient characteristics are presented in detail in Table 1.

Patient satisfaction

Ninety-six percent of women (n = 69) returned the questionnaire. Some women did not answer all questions, resulting in different totals. Responders and non-responders did not differ with regard to age or complication rate.

Overall patient satisfaction was very high, with a mean satisfaction of 8.4 out of 10. Over 80% of patients were very satisfied scoring 8 or higher while only 2 patients, who both had suffered partial necrosis of mastectomy skin flaps, scored less than 6 (Figure 1). More detailed information on specific aspects of patient satisfaction and their relationship with overall satisfaction is given in Table 2. Satisfaction with symmetry, scars on the reconstructed breast, and nipple/NAC were significantly related to overall patient satisfaction. Patients with and without nipple reconstruction were equally satisfied with the end result (Student's *t*-test, p = 0.701), as were patients who had experienced complications and patients who had not (Student's *t*-test, p = 0.749).

Table 1 | Patient characteristics of 72 women with 99 completed DIEP flap breast reconstructions.

General (mean; range)		
Age at time of reconstruction (years)	48	23 – 69
Follow-up (years)	2.4	1.0 – 3.8
Body Mass Index (kg/m^2)	26.1	18.4 – 34.7
Site of breast reconstruction (n; %)		
Unilateral	45	62.5
Bilateral	27	37.5
Timing of breast reconstruction (n; %)		
Primary*	11	15.3
Secondary**	43	59.7
Tertiary***	11	15.3
Combination of primary, secondary, or tertiary	7	9.7
Reason for breast reconstruction (n; %)		
Oncologic mastectomy	49	68.1
Prophylactic mastectomy	21	29.2
Failed cosmetic breast augmentation	2	2.8

* Reconstruction immediately after mastectomy.

** Delayed reconstruction in patients who had not previously received breast reconstruction.

*** Delayed reconstruction in patients who had previously received breast reconstruction.

Figure 1 | Overall patient satisfaction with end result of 67 patients with DIEP flap breast reconstructions. Patient satisfaction score is presented on a 10-point scale (1 = extremely dissatisfied; 10 = extremely satisfied) on the x-axis and number of patients on the y-axis.

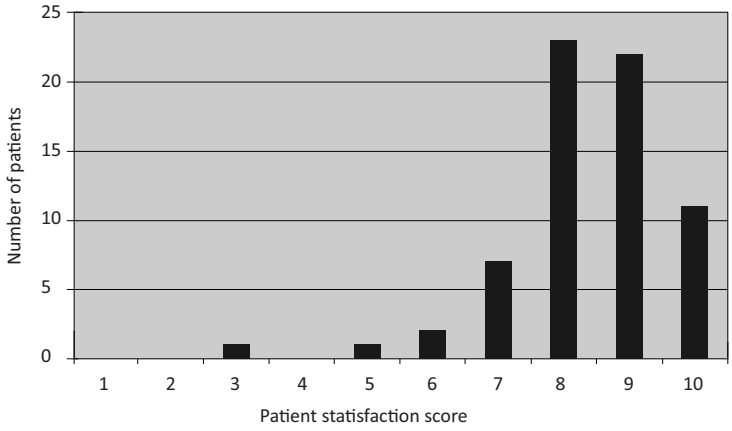

Table 2 | Satisfaction with different breast characteristics of 69 patients with DIEP flap breast reconstructions and relationship with overall satisfaction.*

Satisfied with aesthetic end result with regard to:	n**	Yes! n (%)	Yes n (%)	? n (%)	No n (%)	No! n (%)	β	p
a) Volume?	69	33 (48)	31 (45)	2 (3)	3 (4)	0 (0)	-.07	0.60
b) Shape?	69	31 (45)	30 (44)	4 (6)	3 (4)	1 (1)	-.17	0.34
c) Symmetry?	66	24 (36)	29 (44)	6 (9)	7 (11)	0 (0)	.33	0.04
d) Softness?	69	33 (48)	32 (46)	2 (3)	2 (3)	0 (0)	.17	0.26
e) Scar on breast?	69	22 (32)	35 (51)	2 (3)	8 (12)	2 (3)	.50	0.00
f) Nipple/NAC***	69	23 (33)	24 (35)	7 (10)	5 (7)	1 (1)	.32	0.02
g) Scar on abdomen?	68	18 (27)	27 (40)	6 (9)	13 (19)	4 (6)	-.02	0.90
h) Shape of abdomen?	69	19 (28)	34 (49)	2 (3)	12 (17)	2 (3)	-.15	0.23

Yes! = very satisfied; Yes = satisfied; ? = neutral; No = dissatisfied; No! = very dissatisfied

* Linear regression analysis with patient satisfaction as outcome variable, adjusted for age, timing of reconstruction, follow-up period, and complications.

** Sixty-nine women returned the questionnaire, but some women did not answer all questions, resulting in different totals.

*** Not applicable in 9 patients who did not want a nipple reconstruction.

Additional operations

A total of 104 additional operations were performed in 72 patients, averaging 1.4 operations per patient (range 0 – 4; Table 3). Fourteen additional operations were required in 25 patients (35%) who suffered minor or major complications after their initial reconstruction. Patients with complications underwent 1.9 additional operations compared to 1.2 for patients without complications (Mann-Whitney *U* test, p = 0.002). There was no relationship, however, between occurrence of complications and the number of additional aesthetic operations or the choice for nipple reconstruction (data not shown).

Ninety operations were performed for aesthetic improvements. Details on the number and types of these additional aesthetic operations are specified in Table 4. Unilateral and bilateral reconstructions and groups stratified by timing of reconstruction were compared. Patients with nipple reconstruction were significantly younger than patients without (mean, 47.2 and 53.5 years, respectively; Student's *t*-test, p = 0.035). More women with tertiary reconstructions refrained from nipple reconstruction (45%) than women with primary (9%) and secondary (12%) reconstructions. Controlling for age, logistic regression analysis indicated that this effect is nearly significant (p = 0.052). Abdominal improvements, such as scar and dog-ear corrections, were more frequently performed in bilateral than in unilateral reconstructions (22% vs. 4%; Fisher's exact test, p = 0.046).

Table 3 | Number of additional operations needed to achieve a pleasing end result in 72 patients with DIEP flap breast reconstructions.

Number of additional operations per patient	Overall n (%)	Unilateral n (%)	Bilateral n (%)	Primary* n (%)	Secondary* n (%)	Tertiary* n (%)
0	6 (8)	4 (9)	2 (7)	1 (9)	2 (5)	2 (18)
1	37 (51)	20 (44)	17 (63)	6 (55)	21 (49)	6 (55)
2	22 (31)	17 (38)	5 (19)	2 (18)	17 (40)	3 (27)
≥ 3	7 (10)	4 (9)	3 (11)	2 (9)	3 (7)	0 (0)
Total	**72**	**45**	**27**	**11**	**43**	**11**

Additional operations for both aesthetic improvements and complications are included. Initial reconstruction and NAC tattooing are not considered additional operations.

NAC = nipple areola complex

* 7 patients with a combination of primary, secondary, or tertiary reconstructions were not taken into account.

Table 4 | Overview of additional aesthetic procedures performed in 72 patients after DIEP flap breast reconstruction. In most patients, multiple procedures were performed in one operation.

Type of additional aesthetic procedures	n	%
Reconstructed breast (n = 72)		
Nipple reconstruction	59	81.9
Additional improvements to shape or volume	17	23.6
Shaping by excision of skin or fat	10	13.9
Reduction mammoplasty	4	5.6
Mastopexy	4	5.6
Lipofilling	5	6.9
Liposuction	5	6.9
Scar revision	14	19.4
Dog-ear correction	6	8.3
Excision of fat necrosis	4	5.6
Contralateral breast (in unilateral reconstructions; n = 45)		
Mastopexy	12	26.7
Reduction mammoplasty	4	8.9
Abdomen		
Dog-ear correction, scar revision, or liposuction	8	11.1

Complications after additional operations

No complications occurred after any of the additional aesthetic operations. Only one patient, who had experienced partial DIEP flap failure which required a latissimus dorsi transposition, suffered from wound healing problems. This complication was managed conservatively.

DISCUSSION

In this study, the number of additional operations needed after DIEP flap breast reconstruction was evaluated. It was found that on average 1.4 additional operations were needed to achieve a satisfactory end result for the patient. In our series, the mean time between operations was 8 months and completion of the process took 10 months on average. Ideally, time between initial breast reconstruction and additional operations should only be 3 to 6 months, thus allowing breasts to sag and wounds to heal. Unfortunately, high demands in combination with limited resources resulted in surgery waiting lists and delay in the reconstruction process in our setting.

Patients were very satisfied with the end result of their DIEP flap breast reconstruction with a mean overall score of 8.4 out of 10. Satisfaction with symmetry, scars on the reconstructed breast, and nipple/NAC were most important aspects of the reconstruction affecting overall patient satisfaction. Andrade et al. found a similar association between breast size, shape, and scars on the reconstructed breast and overall cosmesis.[17] In contrast to an earlier report,[18] satisfaction was not related to occurrence of complications. Several patients with serious complications still expressed overall satisfaction with their reconstruction.

Literature on the number of additional operations is limited and it is difficult to compare our data to previous reports because procedures rather than operations were evaluated.[10-12] Malyon et al. performed 2.7 additional procedures per patient with a DIEP flap breast reconstruction.[12] Losken et al. reported an average of 3.99 additional procedures (including NAC tattooing) for unilateral and 5.54 for bilateral pedicled transverse rectus abdominis musculocutaneous (TRAM) flap breast reconstructions.[11] Their raw data indicated that 2 to 3 operations were required in total, which is in accordance with data from the present study. Conversion of our data from operations per patient to procedures per patient resulted in an average of 2.8 additional procedures per patient.

In the current study, 13% of patients did not want nipple or NAC reconstruction and women declining nipple reconstruction were older than women with nipple reconstruction. These results are comparable to previous reports.[12,19,20] Our data showed a trend that women with tertiary reconstructions are less likely to strive for a completed reconstruction than women with primary or secondary reconstructions. Possibly patients with a more extensive medical history have different expectations of the reconstruction and are more easily pleased with the end result.

Previous studies are conflicting as to whether nipple reconstruction improves patient satisfaction. Some investigators doubt the added benefit,[18,20,21] while others report a significantly higher satisfaction.[17,19] In the present study, no correlation was detected

between nipple reconstruction and overall satisfaction, but specific patient satisfaction with nipple/NAC was associated with overall satisfaction. This also suggests that aspects other than solely the aesthetic result, such as patients' personality, expectations, and coping must play an important role.

It would seem less difficult to achieve a symmetrical result in bilateral DIEP flap breast reconstructions compared to unilateral reconstructions at the initial operation. Unilateral reconstructions in women with hypertrophic or ptotic contralateral breasts, as well as in very obese women with bulky DIEP flaps often require additional operations to improve their results. No statistically significant differences, however, could be discerned in number or type of additional breast operations between unilateral and bilateral reconstructions. Additionally, excessive Body Mass Index (> 30 kg/m^2) was not related to the number of additional corrections.

Immediate reconstruction, especially in combination with a skin-sparing mastectomy, allows preservation of important landmarks such as IMF and skin envelope and should require fewer adjustments. In contrast to Losken et al., who showed that immediate reconstructions significantly decreased the need for additional procedures,[10,11] our series did not demonstrate this benefit for primary reconstructions. This finding was attributed to the relatively small number of primary reconstructions in this study. Furthermore, the surgical oncologists performing the subcutaneous mastectomies often extensively undermined and radically thinned the skin, leading to mastectomy skin flap complications needing additional corrections.[13]

In our series, abdominal procedures were more frequent in bilateral than in unilateral reconstructions. This difference cannot be explained by the operation technique used and is not clinically relevant. Two patients requiring a mesh for abdominal herniation were both unilateral reconstructions.

Results of this study should be interpreted with some caution due to uneven distribution of patients with primary, secondary, and tertiary reconstructions and unilateral and bilateral reconstructions. The small number of primary reconstructions in our series (15%) was caused by a cautious attitude towards immediate breast reconstruction by referring oncologic breast surgeons in our setting. Most primary breast reconstructions were therefore performed in genetically predisposed women who are candidates for bilateral prophylactic mastectomy. Nearly 60% of our study population consisted of secondary reconstructions.

Patient and plastic surgeon decided together whether or not to proceed with additional operations. In general, the plastic surgeon offered or agreed to perform an operation, if it was technically feasible to improve the result and if the risk was acceptable. Why did patients who were not (fully) satisfied cease to pursue further improvements? Did patients stop asking because of the limited perceived improvement compared to the physical and emotional stress that would emerge with further surgery? Did the surgeon stop offering because of unrealistic expectations of patients? These questions could not be answered in the present study.

This study was specifically aimed at improving patient information for patients interested in DIEP flap breast reconstruction. Comparison of the number of additional operations needed after different types of breast reconstruction would be of interest. No such control groups were available since breast reconstruction in our institution

was predominantly performed using autologous tissue. Future studies are directed towards prospective regional multicentre comparisons of outcomes after different breast reconstruction techniques. In this fashion, we hope to improve our ability to quantify the optimal breast reconstruction technique for individual patients.

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High satisfaction rates in women after DIEP flap breast reconstruction

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ABSTRACT

Background

Breast reconstruction (BR) is aimed at improving quality of life (QoL) after mastectomy. Patient satisfaction is an important indicator to evaluate the success of BR. This study explored patient satisfaction and its determinants in women undergoing deep inferior epigastric perforator (DIEP) flap BR as well as the impact of the procedure on body image, sexuality, and QoL.

Methods

Patient satisfaction and QoL was studied in 72 women who underwent DIEP flap BR, using a study-specific questionnaire as well as the Short Form-36 (SF-36).

Results

Patient satisfaction was very high. Approximately 90% of patients reported that they had been sufficiently informed about the procedure and its consequences, that their preoperative expectations had been met, that the reconstructed breast felt like their own, that they would choose the same procedure again, and would recommend this procedure to a friend. Patient satisfaction was positively and significantly related to the reconstructed breast(s) feeling like their own. Women with secondary reconstructions were more positive about changes in sexuality and femininity than women with primary BRs. There were no clinically relevant differences in QoL between our study population and a random sample of Dutch females.

Conclusions

Women with DIEP flap BRs reported high satisfaction rates. However, to compare these satisfaction rates with other forms of BR, prospective studies in comparable groups are necessary.

INTRODUCTION

Despite continuous progress in detection, diagnostics and (breast conserving) treatment of breast cancer (BC), mastectomy remains an important surgical option, either to adequately manage the disease locally or to reduce the significantly increased risk of developing BC in genetically predisposed women.[1-3] This mutilating procedure is a potentially traumatic event in a woman's life, and a wide range of lasting psychological adjustment problems has indeed been described.[4-8]

Breast reconstruction (BR) is aimed at restoring patients' quality of life (QoL) and body image after mastectomy. Different BR techniques are available, using autologous tissue, implants or a combination of both, which can all be performed directly after mastectomy or at a later stage. At the department of plastic and reconstructive surgery of the Erasmus Medical Centre, the deep inferior epigastric perforator (DIEP) flap is the preferred method for (autologous) BR.

To assess the quality and effectiveness of BRs, clinical outcome measures such as morbidity, complications and/or recurrence rates do not suffice. In addition, patient satisfaction and the impact of the procedure on health-related quality of life (HRQoL) should be evaluated in relation to patient's expectations.[9-12] Several studies have evaluated the impact of implant reconstructions and autologous reconstructions using either pedicled or free transverse rectus abdominis musculocutaneous (TRAM) flaps and have documented psychological, social, emotional and functional benefits of BR, including improved psychological health, self-esteem, sexuality and body image.[9,10,13-18] However, studies specifically focusing on satisfaction rates and HRQoL after DIEP flap BRs are limited.[19-21]

The current study was aimed at exploring patient satisfaction and its determinants in women undergoing DIEP flap BR as well as the impact of the procedure on body image and sexuality. In addition, patient's postoperative QoL was compared to normative QoL values from a random sample of Dutch females.

PATIENTS AND METHODS

Patient Sample

Between February 2002 and October 2006, 204 consecutive DIEP flap BR were performed in 155 patients. On 1st October 2006, those patients who had already reached an end result were identified from a database of the department of plastic and reconstructive surgery, in which patient characteristics, medical history, and complications had been collected prospectively.[22] A completed BR was defined as a breast with a reconstructed nipple. Patients were also included if they had declined additional operations one year after DIEP flap BR or if they had undergone an additional operation but refrained from further surgery one year after the last operation. Fifty-seven patients who had not yet finished their reconstructive process by these standards were excluded, as were three patients who had died during follow-up. Patients who had suffered partial or total flap loss were not excluded from this study. Fluency of the Dutch language was an inclusion criterion.

All DIEP flap BRs had been performed by the same plastic surgeon (S.O.P.H.) between February 2002 and October 2005, and included both uni- and bilateral reconstructions. Only patients with primary (amputation and direct BR in one operation) or secondary BR(s) (amputation and delayed BR in separate operations) were included in this study. Fourteen tertiary BRs (BR in patients who had previously undergone another type of BR) and nine combinations of primary, secondary, or tertiary BRs were excluded. None of the patients had disease activity at the time of BR.

This study was part of a prospective follow-up study on the psychological effects of different types of BR, which was approved by the institutional ethical committee. Written informed consent was obtained from all patients.

Questionnaire

A study-specific questionnaire was used, modified from a questionnaire previously constructed at our institution to evaluate patient satisfaction after BR.[23,24] Twenty-three questions covered four domains: (1) general satisfaction with DIEP flap BR, (2) feeling informed about the surgical procedure and its possible consequences, (3) peri- and postoperative complications, physical complaints, and limitations attributable to BR, and (4) effects on body image, social functioning, sexuality and femininity. All patients were instructed to use their premastectomy situation as point of reference.

Answers were rated on a five-point Likert scale, ranging from Yes! (extreme satisfaction or very positive change) to No! (extreme dissatisfaction or very negative change). Some questions could also be scored as "not applicable". In addition, a number of questions allowed the left and right breast to be rated separately. Under the assumption that dissatisfaction of one breast would prevail satisfaction of the other breast, the answers to these questions were combined by scoring the breast with the least satisfactory response.

Overall satisfaction was rated on a ten-point scale, ranging from 1 (extremely dissatisfied) to 10 (extremely satisfied). The same overall satisfaction rate had previously been used in relation to the number of additional operations needed after DIEP flap BR to achieve an aesthetically pleasing end result.[25]

In addition to the study-specific questionnaire, patients were asked to complete the Short Form-36 (SF-36) for multidimensional measurement of HRQoL.[26,27] The questionnaire consists of 36 items, which cover eight scales: pain, physical functioning, role physical, role emotional, vitality, mental health, social functioning, and general health. Scores on each scale range from 0 to 100, with higher scores indicating better HRQoL. SF-36 normative data for the general Dutch population are available and reference data from a randomized sample of Dutch females (n = 766) were used for comparison.[28]

Procedure

A pen-and-paper questionnaire with an accompanying explanation and instruction was mailed to all 72 patients who met the inclusion criteria. A prepaid envelope was enclosed for returning the questionnaire. Two weeks after mailing the questionnaire, non-responders were sent a reminder. One month later remaining non-responders were contacted by telephone. No patients were lost to follow-up.

Statistical methods

Differences in age at time of BR, time between mastectomy and BR, and follow-up period since BR, were analysed with *t*-tests for independent samples, after transformation to a normal distribution.

Hierarchical linear regression analysis was performed with overall patient satisfaction as outcome variable. After forcing age at time of BR, time between mastectomy and BR, and follow-up period since BR into the analysis, we regressed the items in a backward procedure on the residuals of the first step.

To gain insight into the structure of the questionnaire, factor analysis was performed using the maximum likelihood method and an oblique rotation.[29] The number of factors was determined using Monte Carlo analysis and a scree test. The factor scores were subsequently saved and analysed with t-tests for independent samples to determine differences between women 1) with primary and secondary BRs, 2) with and without a history of breast cancer, 3) with and without a genetic predisposition to develop BC, and 4) with uni- and bilateral reconstructions.

Respondents' scores on SF-36 subscales were compared to normative data for Dutch females using unpaired t-tests. In addition, similar comparisons were made within our population using the same four sub samples as described above for the factor analysis.

Two-tailed probabilities < 0.05 were accepted as statistically significant. Statistical analyses were performed using SPSS version 15.0 (SPSS Inc, Chicago, Ill). This study served as an explorative pilot study for a prospective study, which is currently being performed investigating patient satisfaction and psychological implications of different BR techniques, and therefore no correction for multiple testing was deemed necessary.

RESULTS

General

Seventy-two eligible women were contacted for the current study. Two women had deceased during follow-up. Sixty-seven of the remaining 70 patients returned their questionnaire, reflecting a response rate of 96%. Some women did not answer all questions, resulting in different totals.

Responders were younger than non-responders, which was not statistically significant (50 vs. 57 years, $p = 0.21$). Patient characteristics of responders are presented in Table 1. Women with primary reconstructions were younger at the time of BR and more frequently carried a mutation in the BRCA 1 or 2 gene. Women with secondary reconstructions more often had a history of BC and underwent more unilateral BRs.

Patient satisfaction

Detailed information on patients' responses is given in Table 2. About 90% of patients reported that they had sufficiently been informed about the procedure and its consequences, that their preoperative expectations had been met, that the reconstructed

breast felt like their own, that they would choose the same procedure again, and would recommend this procedure to a friend. Similar percentages of patients were satisfied with the result, regardless of wearing clothes in general, V-neck tops, bathing suits or no clothes. Nearly 40% of patients reported peri- or postoperative complications, but only six percent continued to experience limitations in daily life.

The mean satisfaction score for DIEP flap BR was 8.4 on a ten-point scale, with over 85% of patients scoring 8 or higher and only 3 patients scoring less than 6.

Table 1 | General characteristics of patient groups.

	Total (n = 67)	Primary BRs[a] (n = 16)	Secondary BRs[b] (n = 51)	p
General (mean; range)				
Age (years)	50.3 (26-71)	43.4	52.5	0.02*
Age at BR (years)	47.9 (23-69)	40.7	50.1	< 0.001
Time between mastectomy and BR (years)	2.6 (0-11.3)	0.0	3.4	< 0.001
Follow-up period since BR (years)	2.9 (1.0-4.7)	3.1	2.8	0.45
Married/ common law (n; %)	55 (82)	14 (88)	41 (80)	0.72
Medical History *(n; %)*				
Breast cancer history	61 (91)	10 (63)	51 (100)	< 0.001
BRCA1/2 mutation carrier	9 (13)	8 (50)	1 (2)	< 0.001
Type of reconstruction *(n; %)*				
Unilateral	50 (75)	6 (38)	44 (68)	< 0.001
Bilateral	17 (25)	10 (63)	7 (14)	

[a] Amputation and direct BR in one operation.

[b] Amputation and delayed BR in separate operations.

BR = breast reconstruction

* Corrected for unequal variances.

Table 2 | Patient responses to study-specific questionnaire.

Question	Total n	YES! %	yes %	? %	no %	NO! %
Were you sufficiently informed about the BR, its consequences and its result?	67	54	36	4	4	1
Did the BR meet your expectations?	66	62	30	3	2	3
Did you suffer complications?	67	25	16	1	15	42
Do you have ongoing complaints?	67	9	4	1	31	54
Do you have complaints with regard to the BR?	65	8	5	0	23	65
Are you currently limited in daily life as a consequence of the BR?	66	3	3	5	35	55
Would you opt for this type of BR again?	67	81	12	3	0	4

Continued Table 2 | Patient responses to study-specific questionnaire.

Question	Total n	YES! %	yes %	? %	no %	NO! %
Would you recommend this procedure to a good friend?	67	75	16	6	0	3
Are you satisfied with your breast(s) when dressed?	66	80	14	3	0	3
Are you comfortable wearing V-neck tops?	67	75	18	1	1	4
Are you comfortable wearing a bathing suit?	66	68	20	2	6	5
Are you satisfied with your breast(s) when undressed?	67	37	51	6	3	3
Do you feel aggrieved at getting undressed in front of your partner?	58	5	3	0	26	66
Did you gain confidence in social situations?	64	39	22	23	9	6
Did the operation change the feeling in your breast(s)?	67	36	31	7	16	9
Do(es) your breast(s) feel like your own?	67	31	58	0	9	1
Do you feel at ease when you touch your own breast(s)?	67	49	40	4	3	3
Do you feel at ease when your partner touches your breast(s)?	55	47	40	5	5	2
Does your partner find you less feminine?	55	2	0	0	29	69
		Very positive	**Positive**	**Neutral**	**Negative**	**Very negative**
	n	**%**	**%**	**%**	**%**	**%**
Did the operation change your feeling of femininity?	67	34	15	42	6	3
Did the operation change your sexual experience?	55	11	15	69	4	2
Did the operation change your partner's sexual experience?	53	2	11	83	4	0

Determinants of overall satisfaction

Women who were less satisfied with their BR, less frequently reported that their breasts felt like their own, were less satisfied with their breasts when dressed, and had more complaints related to the BR (Table 3).

Factor analysis

Factor analysis revealed three factors within our questionnaire, which can be interpreted as: 1) satisfaction, 2) sexuality and femininity, and 3) perceived limitations and complaints (Table 4). T-tests revealed that women with secondary BRs, a history of breast cancer, no genetic predisposition to develop BC, or a unilateral reconstruction reported more positive changes in sexuality and femininity than women with primary BRs, no history of BC, an increased risk of developing BC due to a genetic predisposition, or with a bilateral BR, respectively (Table 5).

Table 3 | Linear regression analysis with overall patient satisfaction as outcome variable, adjusted for age at time of BR, time between mastectomy and BR, and follow-up period since BR.

	B (CI)	Beta	p
First step:			
Constant	8.93 (6.75 – 11.10)		< 0.001
Age at BR	0.00 (-0.04 – 0.04)	-0.00	0.97
Years between mastectomy and BR	0.10 (-0.06 – 0.26)	0.16	0.22
Follow-up period since BR (years)	-0.29 (-0.58 – -0.01)	-0.25	0.046
Second step:			
Constant	0.28 (-1.00 – 1.56)		0.66
Do(es) your breast(s) feel like your own?	-0.59 (-0.87 – -0.31)	-0.36	< 0.001
Are you satisfied with your breast(s) when dressed?	-0.65 (-0.99 – -0.30)	-0.35	< 0.001
Do you have complaints with regard to the BR?	0.39 (0.18 – 0.61)	0.31	< 0.001

BR = breast reconstruction, B = regression weight, CI = confidence interval, Beta = standardised regression weight

Table 4 | Pattern matrix of the factor analysis into the structure of the questionnaire revealing three different correlations between items and factors: 1) satisfaction, 2) sexuality and femininity, and 3) perceived limitations and complaints. For means of clarity correlations below 0.10 are not displayed. Loadings over 0.50 are printed bold.

	Satisfaction	Sexuality and femininity	Perceived limitations and complaints
Would opt for BR again	**0.93**		
Would recommend it to a friend	**0.92**		
Satisfied when dressed	**0.88**	0.14	
Comfortable wearing V-neck top	**0.76**		0.11
Satisfied undressed	**0.73**		
Breast(s) feel(s) like own	**0.67**		
Increased confidence	**0.55**	-0.26	0.14
BR met expectations	**0.54**	-0.15	-0.16
Comfortable wearing bathing suit	0.49	-0.12	
Sufficiently informed	0.41	-0.19	
Aggrieved to undress in front of partner	-0.31		
Complications	-0.31		0.15
Changed feeling in breast(s)	-0.14		0.10
BR changed sexual experience	0.23	**0.95**	-0.17
BR changed feeling of femininity	-0.13	**0.61**	
BR changed partners sexual experience		**0.60**	0.14
Limitations in daily life			**0.80**
Partner finds you less feminine	0.20		**0.75**
Complaints regarding BR	-0.40		**0.60**
Ongoing complaints	-0.31	0.13	**0.51**

Table 5 | Comparison of different factor scores using t-tests between women 1) with primary and secondary BRs, 2) with and without a history of breast cancer, 3) with and without a genetic predisposition to develop BC, and 4) with uni- and bilateral reconstructions. The groups with the higher scores are printed bold.

		Factors					
		Satisfaction		Sexuality and femininity		Perceived limitations and complaints	
Patient groups	**n**	**d**	**p**	**d**	**p**	**d**	**p**
Primary/ **Secondary BR**	16/51	0.20	0.23	0.84	0.002*	0.00	0.89
No breast cancer/ **breast cancer**	6/61	0.58	0.27	1.06	0.003*	- 0.21	0.43
No increased risk to develop BC/ increased risk to develop BC	58/9	- 0.48	0.14	- 0.90	0.000*	- 0.10	0.92
Unilateral/ bilateral BR	50/17	- 0.43	0.64*	- 0.67	0.005*	0.26	0.32

d = Cohen's d, effect size, a positive value reflects a higher score for the second group.
* Corrected for unequal variances.

General health – Quality of life

The scores on the SF-36 subscales of our study population as well as a random sample of Dutch females[28] are presented in Table 6. Age distribution did not differ significantly between both groups (p = 0.15). Patients with DIEP flap breast reconstruction had significantly less pain (p = 0.03) and a tendency to function better physically (p = 0.07) than the control population. There were no differences within our population between different sub samples such as primary or secondary reconstructions (data not shown).

Table 6 | SF-36 subscale scores of 67 women with DIEP flap breast reconstruction compared to a normal sample of 766 Dutch women.

	Control group[a]			DIEP flap BR					
	n	**Mean**	**SD**	**n**	**Mean**	**SD**	***t***	**df**	**p**
Pain	766	71.9	23.8	65	78.8	26.4	2.11	829	0.03
Physical functioning	766	80.4	24.2	67	85.2	16.9	1.81	831	0.07
Role physical	766	73.8	38.5	65	74.4	39.6	0.11	829	0.91
Role emotional	766	78.5	35.7	65	77.9	37.4	0.12	829	0.91
Vitality	766	64.3	19.7	65	63.9	22.5	0.14	829	0.89
Mental health	766	73.7	18.2	65	75.9	17.7	0.96	829	0.34
Social functioning	766	82.0	23.5	65	83.3	21.6	0.44	829	0.66
General health	766	69.9	20.6	64	68.8	19.5	0.42	828	0.67

[a] Derived from Aaronson et al.[28]
SD = standard deviation
t = Student's *t*-value
df = degrees of freedom

DISCUSSION

The current study was aimed at exploring patient satisfaction and its determinants in women undergoing DIEP flap BRs, as well as to assess the impact of this procedure on body image, sexuality and HRQoL.

Overall, patients were very satisfied, as indicated by the high percentage of patients whose expectations had been met, who would choose the same procedure again and who would recommend it to a friend. A mean satisfaction score of 8.4 on a ten-point scale for DIEP flap BR was reported previously.[25] Nine out of ten patients in our sample were satisfied with the result, regardless of wearing clothes in general, V-neck tops, bathing suits or being undressed. Interestingly, the percentage of women who were very satisfied decreased steadily, as clothing became less concealing. This confirms that more intimate situations make increasing demands on the BR. As these differences probably also exist in unaffected women in the general population, no specific conclusions can be drawn without taking women's preoperative attitudes into account.

The percentage of women reporting complications in this questionnaire was the same as the overall complication rate we previously observed in largely the same population (42%).[22] Interestingly, however, there was a big discrepancy between the complications that had been registered in our database ("objective reality") and the complications that were reported by the women in the questionnaire ("perceived reality"). Thirty-seven percent of registered complications were not experienced as such by patients and included microsurgical revision, partial flap failure, and wound dehiscence. Reported complications that had not been registered in the database (24%) consisted of minor wound healing problems and infections.

We previously observed and reported that the first 24 patients of our DIEP flap series suffered more complications, and represented our learning curve.[22] As these patients were included in this study, this might explain the relationship between the length of the follow-up period and patient satisfaction. After adjustment for this and other possible confounders, we found three other items to be significantly related to patient satisfaction. "Are you satisfied with your breasts when dressed" and "Do you have complaints with regard to the BR" are quite straightforward items and speak for themselves. The most important determinant of patient satisfaction was the reconstructed breast feeling like a patient's own, which was also found by Bresser et al.[23] Only 10% of our responders reported that the reconstructed breast(s) did not feel like their own, while nearly half of the women with an implant BR stated this.[23] We assume that these observations are a logical consequence of the use of autologous tissue and underlines one of the DIEP flap's main benefits.

Previous studies in women undergoing primary reconstructions using implants showed (dis)satisfaction to be related to (lack of) preoperative information.[23,30] After controlling for other effects, no such correlation was found in our series, as about 90% of patients reported to be sufficiently informed about the procedure and its consequences. Preoperative information was given orally and in writing at the outpatient clinic and patients were enabled to contact patients who had already undergone the same procedure. Both the type of reconstruction and its timing could influence the provision of information. In general one would expect patients undergoing secondary reconstructions to have more time and opportunity to gather information. In addition, DIEP flap BRs are

more demanding for patients than implant reconstructions, and one would expect a more thorough evaluation of pros and cons (by both plastic surgeon and patient) before deciding in favor of this procedure.

Two groups of patients could be identified in our population, those with a primary and those with a secondary reconstruction. A patient with a history of BC generally undergoes a unilateral secondary reconstruction, while a genetically predisposed woman is more likely to undergo a bilateral prophylactic mastectomy and primary BR. A medical history of BC, an increased risk to develop hereditary BC, and timing of reconstruction might influence patients' expectations for BRs and consequently their satisfaction rates. Women with primary reconstructions will compare their reconstructed breast(s) to their natural breast(s) and might therefore be more critical.[24] The experience of a mutilated body due to a previous mastectomy might result in women with secondary reconstructions being more easily pleased. Similarly, the psychological impact of a therapeutic mastectomy (aimed at treating BC) differs from that of a prophylactic mastectomy (aimed at preventing BC). In addition, there are technical differences between reconstructions. Primary reconstruction, especially in combination with skin-sparing (prophylactic) mastectomy, often allows preservation of important aesthetic landmarks such as infra-mammary fold (IMF) and skin envelope, which should yield a superior result. However, in case the IMF is destroyed, it is more challenging to restore it primarily than to recreate it secondarily. Also, it would seem easier to achieve a symmetrical result in bilateral DIEP flap breast reconstructions compared to unilateral reconstructions.

According to the factor analysis, women undergoing primary and secondary BRs have different perspectives with regard to changes in sexuality and femininity, while satisfaction and perceived limitations and complaints are similar. Women with secondary BR and other related characteristics were significantly more positive about this factor, than women with primary reconstructions who experienced more untoward changes in their sexual relationship due to the (prophylactic) mastectomy and BR. These findings are in accordance with those of previous reports.[31,32] In this light, however, the used point of reference is essential, as women with primary and secondary reconstructions have different starting points and expectations. Even though all patients were instructed to take the pre-mastectomy situation as reference point, respondents with secondary reconstructions might have referred to their post-mastectomy situation. The positive changes reported in femininity and sexuality support this speculation; it seems hard to believe that women would experience positive changes after a reconstructive procedure when compared to the situation before mastectomy. Therefore, prospective follow-up studies are needed to unravel this issue.

Cognitive dissonance is a psychological phenomenon that might play a role in the reported high satisfaction rates after DIEP flap reconstructions. This is the psychological discomfort caused by inconsistency among a person's beliefs, attitudes, and/or actions. Cognitive dissonance induces a "drive state" – a need to avoid or reduce dissonance by changing beliefs, attitudes or behaviors so they are perceived as consistent.[33] In the current study this could imply that patients who deliberately chose to undergo the complicated and demanding DIEP flap procedure (while less aggravating possibilities were also offered), reported high(er) satisfaction rates to avoid post-decision dissonance. Similarly, patients who were less involved in the decision-making and for example underwent implant BR

without being fully aware of (autologous) alternatives, might be (or seem) less satisfied because they feel less responsible for the choice of BR and consequently its end result. Further research could shine a light on this issue.

Generic questionnaires such as SF-36 are designed to detect general changes in HRQoL, rather than capture changes in specific aspects of health. Previous studies on the impact of BR using the SF-36 as an outcome measure have shown a diversity of changes or differences when compared to the preoperative situation or the control population, especially in the subscales social functioning, mental health, and vitality.[9,10,12,14,18,20,34] In our series, patients with DIEP flap BR had significantly less pain ($p = 0.03$) and a tendency to improved physical functioning ($p = 0.07$) than the general female population. Neither of these findings can be explained by the DIEP flap procedure. If anything, one would expect patients who underwent major surgery to have more pain and decreased physical functioning. However, patients undergoing major elective surgery are a positive selection of the general population: plastic surgeons would rather select patients in good physical shape as suitable candidates for DIEP flap BR (confounding-by-indication) and, similarly, patients with extensive co-morbidity are less likely to pursue such a demanding procedure. The assumption that both groups were incomparable at baseline could not be tested, as this pilot study did not take preoperative QoL into account.

CONCLUSION

Current findings show high levels of patient satisfaction after DIEP flap breast reconstruction. It would be of interest to compare these results to satisfaction rates of other BR techniques reported in literature. Previous comparisons between autologous and non-autologous BRs mostly yielded equal satisfaction rates, while only a minority of reports showed significantly higher patient satisfaction after autologous BR.[15,21,35-38] At first glance our results might suggest higher patient satisfaction after DIEP flap BR than after implant reconstruction as well. Direct comparison is complicated, however, due to major differences in patient characteristics and scoring systems.[23,24] Therefore, remarkable differences in for example patient satisfaction, ongoing complaints, and whether or not the reconstructed breast felt like their own cannot be attributed purely to the type of BR. A prospective multicentre study is currently being performed, which is aiming at the direct comparison of outcomes after different breast reconstruction techniques, and is also taking women's preoperative attitudes and expectations into account. In this fashion, we hope to improve our ability to quantify the optimal breast reconstruction technique for individual patients.

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Surgical results, aesthetic outcome, and patient satisfaction after microsurgical autologous breast reconstruction following failed implant reconstruction

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ABSTRACT

Background

The majority of breast reconstructions (BR) are performed using implant material. Implants have some major long-term disadvantages. Long-term implant related complications and improved microsurgical techniques have led to an increased number of women requesting conversion of their implant BR to autologous BR. Aim of this study was to evaluate surgical and aesthetic outcome and patient satisfaction after tertiary autologous BR.

Methods

Between 2002 and 2007, 42 women underwent 61 tertiary autologous BRs. Surgical outcome and complications were evaluated. Patient satisfaction was assessed using a study-specific questionnaire. Aesthetic result was rated by an expert panel using standardized photographs.

Results

Forty-seven DIEP, ten mini-TRAM, and four TMG flaps were performed. Eight patients required re-operation due to complications (19%). Total flap loss did not occur. Nineteen patients underwent one or more additional operations to improve aesthetic outcome. Physical discomfort caused by implants and dissatisfaction with the aesthetic result were the main patient motivations to opt for autologous BR. Reduction or disappearance of physical discomfort was noted in the vast majority of patients. Most patients were very satisfied with the aesthetic result (mean, 8 out of 10), but mean panel satisfaction score was lower (7 out of 10). However, the panel noted a significant improvement of the aesthetic result after conversion into autologous BR (from 5 to 7 out of 10).

Conclusions

Autologous BR after failed implant reconstruction is a technically feasible and reliable procedure, which leads to improved physical condition and aesthetic results and a high patient satisfaction.

INTRODUCTION

The majority of breast reconstructions (BR) are performed using implant material. Implant BR is generally considered as a simple method because of the straightforward operative technique and short operation time. Implant BR has some major long-term disadvantages such as implant displacement and capsular contracture, requiring implant replacement or removal in up to 50%,[1,2] or resulting in chronic pain and tightness.[3]

Alternatively, BR can be performed using autologous tissue, which is most frequently harvested from the abdomen. In our practice, the deep inferior epigastric perforator (DIEP) flap is the preferred method for autologous BR. If the abdomen does not supply sufficient tissue or if contra-indications prevent its use, gluteal artery perforator (GAP) or transverse musculocutaneous gracilis (TMG) flaps are alternatives.[4,5]

Compared to implant BR, autologous BR requires more (micro)surgical expertise and longer operation times and leads to additional donor-site scarring. In return, however, the reconstructed breast feels more natural, responds to weight changes accordingly, and eliminates the risk of capsular contracture.

Long-term complications after implant BR and the development and availability of improved microsurgical techniques have led to an increased number of women requesting conversion of their (failed) implant BR into autologous BR. These numbers are expected to increase further as there is a huge backlog of women who have undergone implant BR over the last decades. BR in patients who previously underwent any form of BR is defined as tertiary BR, in contrast to immediate or primary BR which is performed during the same operation as the mastectomy and delayed or secondary BR which is performed at a later stage.

Although there is ample literature on autologous BR in general, specific literature on outcome of tertiary BR using autologous tissue is limited.[6-9] Three studies evaluated surgical outcome of only a few cases using abdominal free flaps, however, aesthetic outcome and patient satisfaction were not reported.[6-8] Only one study in 33 patients showed that conversion of implant BR into autologous BR using latissimus dorsi, TRAM, and superior gluteus maximus free flaps was an effective and aesthetically superior alternative for patients who no longer desired silicone implants.[9]

Patient expectations have previously shown to significantly affect psychological outcome after different types of BR.[10] This warrants research specifically focusing on this growing population of women requesting conversion of their previous BR into an autologous BR.

The purpose of this study was: 1) to evaluate surgical outcome and complications; 2) to assess patient motivation and satisfaction with the aesthetic result; and 3) to objectively assess aesthetic outcome after tertiary BR using free flaps.

Patients and methods

PATIENTS AND METHODS

Patient sample

Between February 2002 and December 2007, 45 patients underwent a tertiary BR using free vascularized flaps. Three patients who had simultaneously received a contralateral primary or secondary BR were excluded leading to a target study sample of 42 patients.

Measures

Surgical data

Surgical outcome and complications were evaluated for all 42 patients using a structured and prospectively kept database, for patient characteristics, surgical data and complications. Additional operations to deal with complications or to improve the aesthetic result were analysed as well. Minor complications were defined as complications which could be treated conservatively and major complications were defined as complications which had to be treated surgically.

Patient motivation and satisfaction

Thirty-one patients who had completed their BR at the start of the present study were asked to fill out a study-specific, standardized questionnaire. A completed BR was defined as a neo-breast with a reconstructed nipple. Patients were also included if they had declined additional operations one year after the tertiary BR or if they had undergone an additional operation but refrained from further surgery one year after the last operation.[10]

The questionnaire was modified from an instrument previously constructed at our institution to evaluate patient satisfaction after DIEP flap BR.[10-12] Specific questions were added to assess motivational factors and to compare the occurrence of physical complaints before and after tertiary BR. Answers were rated on a five-point Likert scale, ranging from Yes! (extreme satisfaction or very positive change) to No! (extreme dissatisfaction or very negative change). Some questions could also be scored as "not applicable". In addition, a number of questions allowed the left and right breast to be rated separately. Under the assumption that dissatisfaction of one breast would prevail satisfaction of the other breast, answers to these questions were combined by scoring the breast with the least satisfactory response.

Overall satisfaction was rated on a ten-point scale, ranging from 1 (extremely dissatisfied) to 10 (extremely satisfied).

Aesthetic outcome

All 31 patients with a completed BR were also included for objective assessment of their aesthetic outcome by an expert panel. The expert panel consisted of five experienced plastic surgeons, who were not directly involved in the medical care of these patients. They were asked to rate aesthetic outcome using standardized pre- and postoperative photographs, consisting of a series of five pictures (Figure 1). Fifty-nine series (28 preoperative, 31 postoperative) were randomly presented in a slide show to each individual expert, who had 45 seconds to score satisfaction with volume, shape, symmetry, scarring, and nipple

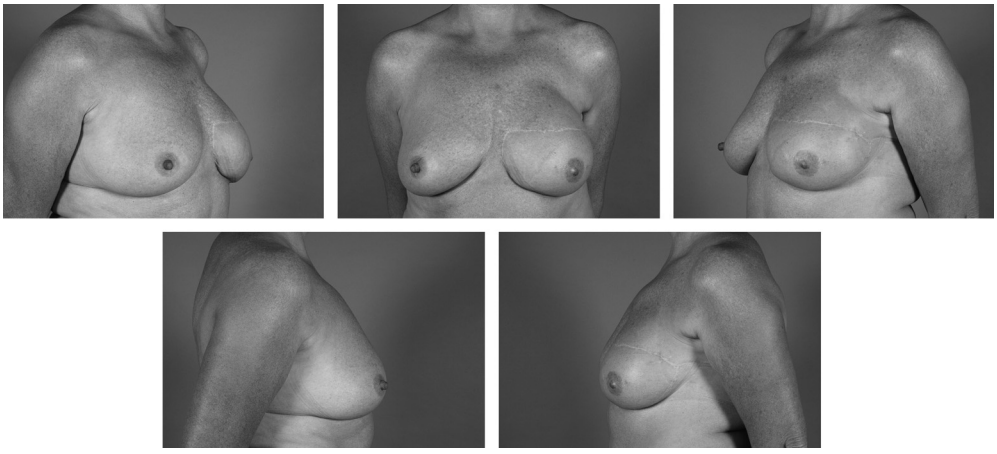
areola complex using a five-point Likert scale. In addition, they were asked to give a general satisfaction score on a ten-point scale.

Procedure

The questionnaire, an accompanying letter and a prepaid envelope were mailed to all 31 patients who met the inclusion criteria. Two weeks after mailing the questionnaire, non-responders were sent a reminder. One month later remaining non-responders were contacted by telephone. No patients were lost to follow-up.

This study was part of a prospective follow-up study on the psychological effects of different types of BR, which was approved by the institutional ethical committee. Written informed consent was obtained from all patients.

Figure 1 | An example of a series of five postoperative standardized photographs as scored by the panel.



Statistical Analysis

Patient data were analysed using chi square and Fisher's exact tests. Patient and panel scores were compared using Wilcoxon signed ranks tests. Spearman correlation coefficients were computed to study relationships between satisfaction with different aspects of breast appearance and satisfaction with the overall aesthetic result.

Inter-observer variability was determined by computing interclass correlation coefficients (ICCs) using two-way mixed models with consistency agreement. Satisfaction scores of patients who had returned the questionnaire were compared to those of the panel. Analysis of the effect of tertiary BR on aesthetic outcome according to the expert panel was limited to those patients with standardized photographs of both the pre- and postoperative situation.

All analyses were performed using SPSS (version 15.0, SPSS Inc., Chicago, USA). P-values < 0.05 (two-sided) were considered statistically significant.

RESULTS

Patient characteristics

In total, 61 tertiary BRs were performed in 42 patients using free vascularized flaps. The majority consisted of DIEP flaps (n = 47), followed by ten mini-TRAM flaps and four TMG flaps. Patient characteristics are presented in Table 1.

Table 1 | Patient characteristics of 42 patients with 61 tertiary free flap breast reconstructions.

Characteristics		
Age at time of reconstruction in years (median; range)	53	(36 – 63)
Follow-up in years (median; range)	2.0	(0.3 – 7.9)
Body mass index (median; range)	26.0	(18.8 – 36.2)
Previous breast operations (median; range)	2	(1 – 19)
One or more risk factors for impaired wound healing (n; %)*	11	(26)
One or more previous abdominal operations (n; %)**	20	(48)
Unilateral BR (n; %)	23	(55)
Bilateral BR (n; %)	19	(45)

* Smoking, diabetes mellitus, and hypertension.

** Pfannenstiel, cholecystectomy, appendectomy, laparoscopy, umbilical hernia repair, and mini-abdominoplasty.

Surgical results

Postoperative complications

Complications requiring a re-operation occurred in eight out of 42 patients (19%). Two flaps required microsurgical revision, of which one resulted in partial flap failure. There was no total flap loss. Two patients were re-operated for hematoma evacuation, three for debridement of partial flap necrosis followed by flap advancement and direct closure, and two for abdominal donor-site problems consisting of wound dehiscence and skin necrosis (Table 2).

Additional operations to improve aesthetic outcome

Nineteen patients (46%) underwent one or more additional operations to improve aesthetic outcome. On average, patients underwent 0.7 additional operation (range 0 – 6). Most performed additional operations were liposuction (n = 9) or lipofilling (n = 8) of the neo-breast, dog-ear correction (n = 9), neo-breast reduction (n = 8), and scar revision of the breast (n = 6) or donor-site (n = 6). Nipple reconstructions were performed in 21 patients

(51%). After combining additional aesthetic procedures with nipple reconstructions, twenty-seven patients (64%) underwent an additional operation.

Table 2 | Number of complications after 61 tertiary free flap breast reconstructions in 42 patients.[a]

	n	%
Major flap complications	**6**	**10***
Hematoma	3	5*
Microsurgical revision	2	3*
Partial flap necrosis	3	5*
Minor flap complications	**2**	**3***
Major donor-site complications	**2**	**5****
Minor donor-site complications	**6**	**14****
Long-term complications***	**5**	**12****

[a] Minor complications were defined as complications which could be treated conservatively and major complications were defined as complications which had to be treated surgically.

* As a percentage of total number of flaps.

** As a percentage of total number of patients.

*** Abdominal bulging/herniation, fat necrosis, wound healing problems.

Follow-up results

Twenty-nine out of 31 patients with a completed breast reconstruction, who were contacted to assess satisfaction with the end result and motivation for choosing autologous BR, filled out the questionnaire leading to a response rate of 94%. Mean follow-up period between tertiary BR and completing the questionnaire was 39 months (range, 12 to 95 months). Pre- as well as postoperative photographs were complete for 25 patients with a mean follow-up period of 20 months (range, 2 to 70 months) between the autologous BR and the photographs taken.

Preoperative patient motivation and physical complaints

The most important reason for opting for tertiary BR using autologous tissue was physical discomfort (pain and tightness) due to the breast implants (68%), closely followed by dissatisfaction with the aesthetic result of the implant BR (64%). In four patients the implant BR had technically failed, requiring implant removal due to infection (14%). Forty percent of all patients with physical discomfort had a Baker II or III capsular contracture at physical examination. Capsular contracture was found in 23% of patients who had been motivated by dissatisfaction with the aesthetic result or technical implant failure (chi square test, $p > 0.05$). Five out of 29 patients (17%) had received radiotherapy in the past. Patients who had received radiotherapy did not more often have preoperative physical complaints or capsular contractures (20%) than patients who had not received radiotherapy (14%; Fisher's exact test, $p > 0.05$). Typical examples of capsular contractures are shown in the preoperative pictures of Figures 2, 3 and 4.

Figure 2 | Pre- and postoperative photographs of a 40-year-old patient who underwent a tertiary autologous BR on the right side, motivated by physical discomfort and dissatisfaction with the aesthetic result. Capsular contracture is evident in the preoperative photograph (above left). The patient benefited from tertiary BR, as she postoperatively reported less pain and tightness of the breast and no abdominal complaints. In addition, she was very satisfied with the aesthetic end-result of both breast (9 out of 10) and abdomen. She underwent two additional operations (nipple reconstruction and liposuction of the reconstructed breast) to improve outcome. The postoperative photographs (above and below right) show the result after 64 months (14 months after the last additional operation).

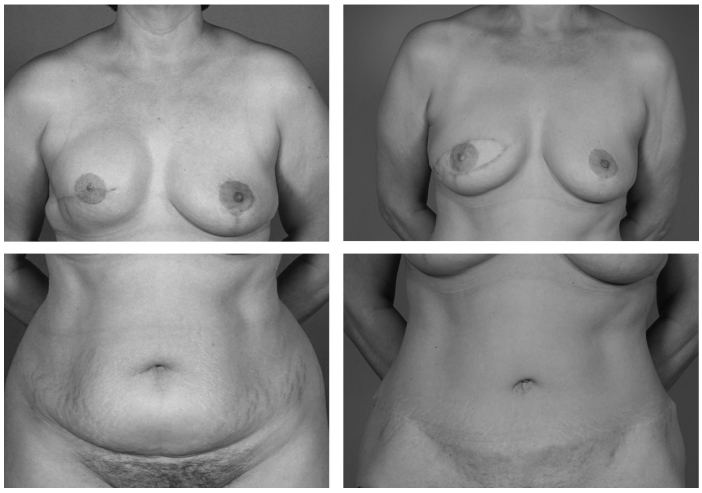


Figure 3 | Pre- and postoperative photographs of a 56-year-old patient who underwent a tertiary autologous BR on the left side, motivated by dissatisfaction with the aesthetic result. Postoperatively, the patient was very satisfied with the aesthetic result of both breast (8 out of 10) and abdomen. She did not have any complaints of the donor-site. One additional operation was performed (nipple reconstruction and necrotectomie of the breast) to reach the result shown after 16 months (5 months after the last additional operation).

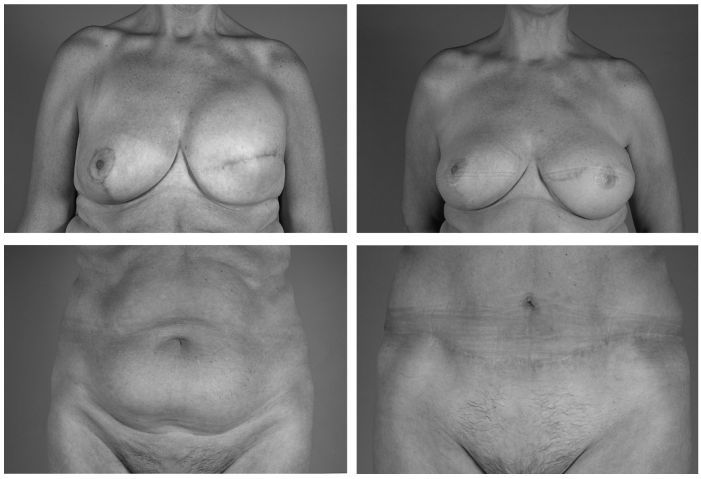
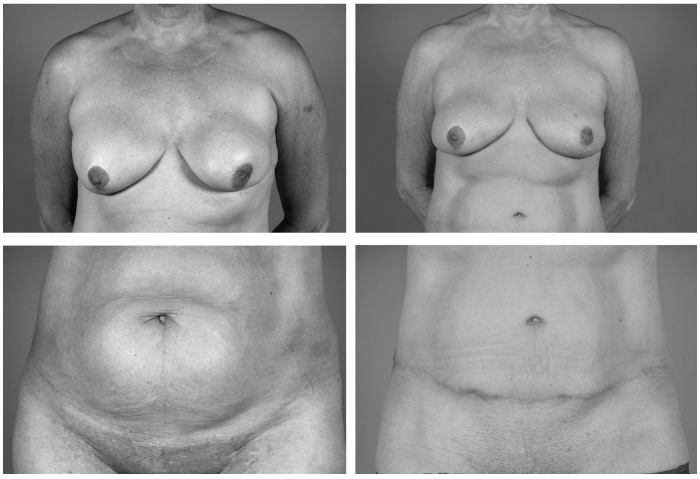


Figure 4 | Pre- and postoperative photographs of a 60-year-old patient who underwent a tertiary autologous BR on both sides, motivated by a technically failed implant reconstruction. The procedure was complicated by a hematoma of the right breast which was surgically evacuated. The patient was dissatisfied with the aesthetic result of both breast (3 out of 10) and abdomen. She was dissatisfied with breast asymmetry and the abdominal scar and contour. She did not report any physical complaints or pain of the donor-site and breasts. One additional operation (abdominal dog-ear excision, inframammary DIEP flap skin island excision, and inverted nipple correction on the left side) was performed to reach the result after 16 months (2 months after the additional corrections).



Patient satisfaction

The vast majority of patients who had been motivated by pain or tightness benefited from autologous BR (75% and 91%, respectively). In addition, about 80% of respondents reported that the newly reconstructed breast felt more like their own, that they felt more feminine, would choose the same procedure again, and would recommend autologous BR to a friend. Detailed information on patients' responses to the study-specific questionnaire is given in Table 3. Patient mean satisfaction score (MSS) was 7.8 out of 10 (range, 3 – 10). Sixteen patients scored ≥ 8 (57%) and only three patients (10%) scored < 6, of whom two had suffered major complications and one had long-term complications. The number of patients who reported to be (very) satisfied with specific aspects of the aesthetic end result is shown in Table 4. Most patients were (very) satisfied with softness (88%), followed by volume (86%), and shape (83%) of their reconstructed breast(s). The number of patients with persisting abdominal donor-site discomfort as tightness, distension, and pain is shown in Table 5. Postoperative results of the tertiary autologous BR and the donor-site are shown in Figures 2, 3 and 4.

Aesthetic outcome

Agreement in perception of the aesthetic end result among the panel members yielded ICC values between 0.58 and 0.90 indicating there was a high level of agreement among the five different panel members (Table 6).

The panel's MSS with different aspects of the aesthetic end result compared to the patient's MSS are presented in Table 5. Patients were most satisfied with breast volume and shape, whereas panel members were most satisfied with nipple areola complex and breast volume. The panel MSS with the overall aesthetic end result was significantly lower compared to MSS of the patients (6.98 ± 0.91 vs. 8.05 ± 1.59; Wilcoxon signed rank test, $Z = 2.70$, $p = 0.007$). Compared to patients the panel members were significantly less satisfied with breast volume, breast shape, and scars (Table 7).

Table 3 | Self-reported patient satisfaction with result and procedure after tertiary free flap breast reconstruction.[a]

	n	%
Sufficiently informed about procedure, its consequences and its result	24/29	83
In accordance with preoperative expectations	24/28	86
Limitations in daily life as a consequence of the BR*	6/29	21
Would opt for this type of BR again	24/29	83
Would recommend this procedure to a friend	23/29	79
Satisfied with the breast when dressed	26/29	90
Comfortable wearing V-neck tops	22/29	76
Comfortable wearing a bathing suit	20/29	69
Satisfied with the breasts when undressed	21/29	72
Overall satisfaction with result and procedure	21/25	84

BR = breast reconstruction

[a] Numbers of patients with a positive answer are shown.

* Tight abdominal scar, limited arm movement, painful arms, abdominal bulging.

Table 4 | Number of patients who reported to be (very) satisfied with specific aspects of the aesthetic end result.

Scores*	n	%
Breast volume	25/29	86
Breast shape	24/29	83
Breast symmetry	17/28	61
Breast softness	26/29	90
Breast scar(s)	20/29	69
Nipple (areola complex)	15/22	68
Abdominal scar	13/29	45
Abdominal contour	14/29	48
Satisfaction with overall aesthetic end result	20/25	80

* Rated on a five-point Likert-scale ranging from 1 (very dissatisfied) to 5 (very satisfied).

Table 5 | Number of patients with persisting donor-site discomfort (n = 25).

	n	%
Overall complaints	5	20
Painful abdomen	5	20
Abdominal tightness	10	40
Abdominal weakness	1	4
Bloated/distended abdomen	6	24

Table 6 | Inter-observer variability in satisfaction levels of 5 panel members.

	Preoperatively		Postoperatively	
Satisfaction with	**ICC scores**	**n*** **	**ICC scores**	**n*** **
Aesthetic end result*	0.894	28	0.848	28
Breast volume**	0.786	28	0.832	31
Breast shape**	0.811	28	0.704	31
Breast symmetry**	0.811	28	0.824	31
Breast scars**	0.694	28	0.790	31
Nipple/NAC**	0.901	10	0.581	15

ICC = interclass correlation coefficient (0 means no agreement at all, 1 means perfect agreement)
NAC = nipple areola complex
* Rated on a ten-point scale ranging from 1 (extremely dissatisfied) to 10 (extremely satisfied).
** Rated on a five-point Likert scale ranging from 1 (very dissatisfied) to 5 (very satisfied).
*** Discrepancy with total number of patients due to missing photographs or absent nipple/NAC.

Table 7 | Mean satisfaction with different aspects of the aesthetic end result (n = 29).

Scores*	Patient	Panel	Z**	n***	p
Breast volume	4.24 ± 0.97	3.65 ± 0.69	2.62	25	0.009
Breast shape	4.16 ± 0.99	3.47 ± 0.63	2.73	25	0.006
Breast symmetry	3.83 ± 1.17	3.48 ± 0.73	1.07	24	0.285
Breast scars	3.92 ± 1.08	3.14 ± 0.60	2.99	25	0.003
Nipple/NAC	3.42 ± 1.24	3.82 ± 0.39	1.20	12	0.229

NAC = nipple areola complex
* Rated on a five-point Likert scale ranging from 1 (very dissatisfied) to 5 (very satisfied).
** Wilcoxon signed rank test.
*** Discrepancy with total number of patients due to missing photographs or absent nipple/NAC.

The relationships between patients' and panel's satisfaction with the overall end result and different aspects of the aesthetic end result are shown in Table 8. For both patients as well as panel there were statistically significant positive correlations between satisfaction with all different aspects of the aesthetic end result and satisfaction with the overall aesthetic end result (Table 8). Patient satisfaction with scars of the reconstructed breast (rs = 0.75) and breast symmetry (rs = 0.64) showed the highest correlation, meaning that patient satisfaction with the overall aesthetic end result was mainly determined by satisfaction with these two items (Table 8). Panel satisfaction with breast symmetry (rs = 0.83), volume (rs = 0.82), and shape (rs = 0.81) had the strongest effect on satisfaction with the overall aesthetic end result (Table 8). There was no correlation between panel and patient satisfaction with the aesthetic end result and follow-up period, meaning that the aesthetic outcome of the autologous BR remains stable over time.

Table 8 | Correlations between satisfaction with different aspects of the aesthetic end result and overall aesthetic end result (n = 29).

	Patient		Panel	
	Spearman's correlation coefficient	**n*** **	**Spearman's correlation coefficient**	**n*** **
Breast volume	0.55*	28	0.82*	28
Breast shape	0.57*	28	0.81*	28
Breast symmetry	0.64*	28	0.83*	28
Breast scar(s)	0.75*	27	0.70*	28
Nipple/NAC	0.44**	22	0.70*	14

NAC = nipple areola complex

* $p < 0.005$.

** $p < 0.05$.

*** Discrepancy with total number of patients due to missing photographs or absent nipple/NAC.

Table 9 shows MSS of the panel with pre- and postoperative aesthetic results. According to the panel, breast volume, shape, and symmetry had improved significantly after tertiary autologous BR. Scars of the reconstructed breast and nipple areola complex were also scored higher postoperatively, yet these differences were not statistically significant, because preoperative satisfaction with these items was already rather high. Mean satisfaction with the overall aesthetic result was also significantly higher after tertiary autologous BR than before (6.82 ± 0.97 vs. 4.81 ± 1.21; Wilcoxon signed rank test, $Z = 3.83$, $p < 0.001$).

Table 9 | Mean preoperative and postoperative panel satisfaction with different aspects of the aesthetic result (n = 31).

Scores*	Preoperative	Postoperative	Z**	n***	p
Breast volume	2.58 ± 0.72	3.58 ± 0.71	3.68	23	< 0.001
Breast shape	1.90 ± 0.66	3.34 ± 0.69	4.11	23	< 0.001
Breast symmetry	2.09 ± 0.73	3.37 ± 0.73	4.06	23	< 0.001
Breast scar(s)	3.10 ± 0.56	3.20 ± 0.66	0.61	23	0.541
Nipple/NAC	3.40 ± 0.82	3.67 ± 0.65	0.63	6	0.528

NAC = nipple areola complex

* Rated on a five point Likert scale ranging from 1 (very dissatisfied) to 5 (very satisfied).

** Wilcoxon signed rank test.

*** Discrepancy with total number of patients due to missing photographs or absent nipple/NAC.

DISCUSSION

The aim of this study was to evaluate surgical results, aesthetic outcome, patient motivation, and patient satisfaction after tertiary autologous BR using free flaps. In the current study 19% of patients had complications requiring re-operation. There was no total flap loss. Most important motivations for opting for autologous BR were physical discomfort and dissatisfaction with the aesthetic result. Reduction or disappearance of physical discomfort was noted in the vast majority of patients who had been motivated by pain or tightness, however, at the expense of abdominal donor-site discomfort in about 20%. Most patients were very satisfied with the aesthetic result after tertiary BR (mean, 8 out of 10). Mean panel satisfaction score was significantly lower (7 out of 10). However, the panel noted a significant improvement of the aesthetic end result after conversion into autologous BR (from 5 to 7 out of 10).

Previous studies reported no surgical complications requiring re-operation.[6-8] These outcomes seem favorable compared to the current study, however, they were obtained from very small patient populations ranging from five to seven patients, making a quantitative and valid comparison difficult. In another study an overall flap survival rate of 94% in 33 patients was found. Complications requiring re-operation were reported in 9% of patients: one microsurgical flap revision and two corrections of abdominal wall weakness.[9] Even though the size of the evaluated patient population approximates the current study, both studies are not comparable as in that previous study pedicled latissimus dorsi flaps and free TRAM and superior gluteus maximus flaps were used in contrast to the present series where mainly free DIEP flaps were used.

The complication rates in the current study are slightly higher than our previously reported numbers where primary and secondary BR were shown to be a safe and reliable procedure.[13] For instance, flap complications requiring revision occurred in only 4% of 24 primary DIEP flap reconstructions[13] compared to 10% in the current series, although this did not lead to total flap losses. In the present study no relationship was found between previous radiotherapy and flap complications. Therefore, the generally extensive previous

surgery in the local area that has developed complications can be accounted for the increased chance of developing complications. Still, we feel the current study shows that tertiary BR using abdominal free (perforator) flaps is a safe albeit challenging procedure.

A total of 46% of the patients underwent one or more additional operations to improve aesthetic outcome, which seems high. Taken into account that most of these patients had minor cosmetic touch-ups in combination with the fact that these women represent a disappointed and cosmetically very aware group of unsuccessful previous breast reconstruction make these numbers very acceptable. These results are in line with our previous study on additional procedures after primary and secondary DIEP flap BR, indicating that the timing of BR does not seem to significantly affect the need for additional aesthetic touch-ups.[14]

Symptomatic capsular contracture is an important reason for conversion of an implant BR into an autologous BR.[7-9] Our study corroborates the findings of previous reports that physical discomfort and dissatisfaction with the aesthetic result, which both were sometimes caused by capsular contracture, are important patient motivations to opt for a tertiary free flap BR.[6-9] One study reported a capsular contracture rate of more than 50% after implant BR.[2] Another study in 309 implant BR patients reported an overall complication rate of 39% and an early implant removal rate up to 30% due to postoperative complications.[1] Implant replacement in combination with capsulotomy/ectomy can be a (temporary) solution for women with capsular contracture. However, capsular contracture is frequently a recurrent problem which can be very difficult to treat, eventually leading to displeasing aesthetic results. In those cases, autologous BR is a viable solution.

In the present study tertiary BR using free flaps lead to very high patient satisfaction rates with reduction of preoperative physical discomfort in the vast majority of cases, however, at the expense of abdominal donor-site discomfort and dissatisfaction in 20% to 40%, respectively. Previous studies also reported a positive change in the majority of patients who had undergone conversion of their implant BR into autologous BR.[6-9] However, only a single study, which is in line with the current study, described actual patient reported satisfaction data with 92% of patients reporting an aesthetic improvement after tertiary autologous BR. In addition, they found that all patients would choose the same procedure again and would recommend it to others.[9]

Interestingly, although in the present series 19% suffered from complications and 46% needed additional surgery to improve outcome, satisfaction scores of women after tertiary autologous BR were very similar to previous studies in women who had undergone primary and secondary BRs, despite very different points of reference and expectations.[10] Possibly the natural aesthetic end result of autologous BR compensates for the short-term disadvantages of additional surgery on the long-term. In addition, patient (dis)satisfaction data can give valuable information to the plastic surgeon as shown in Tables 4 and 5. After our study it became clear that our preoperative information on "limitations after surgery" was inadequate and needed improvement which was effectuated in our preoperative consultation as a consequence.

In the present study, plastic surgeons were significantly less satisfied with overall aesthetic outcome compared to patients. In a previous study assessing aesthetic outcome after nasal reconstruction we found similar results.[15] Using a similar study design to compare nasal appearance perception of panel and patients, mean total nasal appearance

satisfaction scores of the panel were significantly lower compared to the patients.[15] As previously hypothesized it is believed that professional experience of plastic surgeons leads to different expectations compared to patients. Presumably this occurs because their trained professional eye easily detects technical imperfections, which could be refined by additional surgery. In addition, professionals familiar with BR might focus exclusively on isolated features such as imperfect inframammary fold position or slight contour irregularities instead of responding to the appearance of the breasts in total. In contrast, the patient might be more focused on the overall result that is compared to the situation before reconstruction.

Obviously the design of the current study has its drawbacks and limitations. A prospective database was used to evaluate surgical outcome. Patient satisfaction, however, was evaluated retrospectively using a questionnaire, in which patients were asked to compare the postoperative situation with the preoperative situation. When relying on patients´ memory, recall bias is inevitable. Recall bias can be avoided by designing a prospective study in which patients fill out a standardized questionnaire pre- and postoperatively. Such a study is currently being performed in women undergoing primary and secondary breast reconstructions using either autologous tissue or implant material.

Despite the increasing number of women who undergo autologous BR after failed implant reconstruction, absolute numbers are still limited. Only one previous study evaluated a similar number of patients,[9] but most studies included only up to seven patients.[6-8] Our study sample was substantial, however numbers were still too small for more detailed statistical analyses with satisfactory power. Future prospective studies with larger patient samples have to be awaited making more in depth statistical analyses with sufficient power possible.

CONCLUSION

This study shows tertiary BR using autologous tissue is a technically feasible and reliable procedure for women who have previously undergone another type of BR. In case the patient feels the need for additional surgery and risk of complications are an acceptable trade off for her initial problem, she may benefit from tertiary BR using autologous tissue. It leads to improved physical condition and a high patient satisfaction in a majority of patients.

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Medium-term cost-analysis of breast reconstructions in a single Dutch centre: A comparison of implants, implants preceded by tissue expansion, LD transpositions, and DIEP flaps

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ABSTRACT

Background

Free flap breast reconstruction (BR) is generally believed to be more expensive than implant BR, but costs were previously shown to level out over time due to complications and re-operations. The aim of this study was to assess economic implications of four BR techniques: silicone prosthesis (SP), implant preceded by tissue expansion (TE/SP), latissimus dorsi transposition with or without implant (LD ± SP), and deep inferior epigastric perforator (DIEP) flap.

Methods

A prospective historic cohort study was performed to evaluate intramural medical costs in 427 patients who had undergone BR between 2002 and 2009. Short- and medium-term complications were incorporated. Additionally, 58 patients who had recently undergone BR participated in a questionnaire study to prospectively evaluate extramural medical and non-medical costs. Estimates of mean short- and medium-term costs are presented per patient.

Results

Intramural medical costs for BR and short-term complications for unilateral DIEP flaps (€12,848) and TE/SP reconstructions (€12,400) were significantly higher than those for LD ± SP reconstructions (€5,804), which in turn were more expensive than SP reconstructions (€4,731). In bilateral cases, costs of TE/SP (€12,723) and LD ± SP (€10,760) reconstructions were comparable, while DIEP flaps (€15,747) were significantly more expensive and SP reconstructions were significantly cheaper (€6,784). Overall, medium-term costs for complications and additional operations were not significantly different (€3,017 – €4,503). Extramural medical costs and non-medical costs were approximately €9,300 per stage, regardless of technique.

Conclusions

Differences in short-term costs between techniques did not level out during follow-up and SP reconstructions remained least expensive. Single-stage SP reconstructions, however, are not suitable for all patients due to high complication rates. Definite implant placement is therefore increasingly preceded by tissue expansion at more comparable costs to autologous BR. Incorporation of non-medical costs into the cost-analysis would render two-stage procedures more costly than autologous BR. To achieve the optimal result, careful patient selection is critical. Only in select cases where two options are equally applicable, cost comparison becomes a valid argument for treatment selection.

INTRODUCTION

Different techniques are available for breast reconstruction (BR) after mastectomy. Commonly used techniques are silicone prostheses or implants (SP), implants preceded by tissue expansion (TE/SP), pedicled latissimus dorsi flaps with or without implant (LD ± SP), pedicled or free transverse rectus abdominis musculocutaneous (TRAM) flaps, or free deep inferior epigastric perforator (DIEP) flaps. Each technique can be performed directly after mastectomy (primary BR) or at a later stage (delayed or secondary BR).

Multiple factors have to be considered to determine the optimal treatment modality for individual patients. Procedural characteristics have to be regarded in the context of patient-related factors (e.g., age, medical history, body habitus) and the surgeons expertise to assess which methods are technically feasible and which risks acceptable. Radiation therapy, for example, is a relative contra-indication for implant BR due to increased complication rates, while sufficient excess abdominal tissue is a prerequisite for autologous BR using abdominal tissue.[1,2]

When a multiplicity of techniques is available for the treatment of a particular disease, cost and outcome studies are important to demonstrate procedures' economic viability and ensure its unrestricted, continued availability.[3] In the Netherlands, for example, BR using a free flap is generally believed to be more expensive than implant BR, which provides implant-based BR a considerable advantage to insurance companies and might indirectly limit the availability of autologous BR.

Previous studies have compared costs between implant and autologous BRs or between different types of autologous BRs. BRs using implants were (initially) less expensive than autologous BRs,[4] but costs levelled out within 5 years due to complications and re-operations.[5] These studies have contributed to valuable insight into costs and cost-differences between different types of BR. However, some important health economic aspects were not incorporated properly: many studies used charges or fees rather than resource costs to estimate costs,[6-10] while a persistent relation between hospital charges and actual costs does not exist.[3,11,12] Further, the hospital perspective was used, leaving extramural medical costs and non-medical costs unaccounted for. Lastly, no studies have simultaneously assessed all available techniques.

The aim of this study was to comprehensively assess the economic implications of four BR techniques (SP, TE/SP, LD ± SP, DIEP) from a societal perspective based on real resource use in substantial patient groups.

PATIENTS AND METHODS

Study design

Mean total costs of SP, TE/SP, LD ± SP, and DIEP flap BRs were studied from a societal perspective, meaning medical as well as non-medical costs were considered. Medical costs include actual costs due to the medical treatment or its complications. Distinction was made between intramural medical costs (e.g., outpatient visits, inpatient days, surgery, blood tests) and extramural medical costs (e.g., general practitioner consultations, visits

to physiotherapists, in-home nursing care). Non-medical costs included direct costs associated with patients' travel costs and indirect costs resulting from absence from work (productivity costs).

Intramural medical costs were evaluated in a prospective historical cohort study using patient charts and the electronic hospital administration. Extramural medical costs and direct and indirect non-medical costs were assessed using a questionnaire survey.

The study was approved by the medical ethical review committee (MEC-2007-406).

Intramural medical costs

Patients who had undergone primary or secondary BR at the Erasmus Medical Centre between 2002 and 2006 were included. The inclusion period for patients who had received TE/SP reconstructions was prolonged until March 2009, as this technique had only been performed sparsely between 2002 and 2006 and could otherwise not provide a representative study sample. Patients had been carefully selected to undergo the most appropriate type of BR.

BR normally consists of multiple stages: breast mound creation, additional operations improving the aesthetic result or dealing with complications, nipple reconstruction, and nipple areola complex (NAC) tattooing.[13] To evaluate patients who underwent comparable treatments, we distinguished between short- and medium-term costs. Short-term costs consisted of the initial breast mound reconstruction and short-term complications (< 6 weeks). Costs for the mastectomy in case of primary BR and costs of both parts of two-stage procedures (TE/SP, bilateral LD ± SP) were included, as it was technically impossible to separate these costs. Medium-term costs consisted of medium- and long-term complications (> 6 weeks) and additional operations to improve the aesthetic result, not including NAC tattooing. Mean total costs per patient were subsequently calculated by adding short- and medium-term costs.

Short-term costs were analysed for all patients whose breast mound reconstruction had been completed. To be eligible for the medium-term part of the study, patients' entire BR process had to be completed, which was defined as a neo-breast with a reconstructed nipple or NAC. Patients without a nipple reconstruction were also included if they had sustained another additional operation but had refrained from further surgery one year after the last operation. The first 24 patients (30 flaps) of our DIEP flap series were excluded, as we showed previously that these patients represented our learning curve.[14]

Extramural medical costs and direct and indirect non-medical costs

Data regarding extramural health care use, travel, and sick leave were gathered prospectively using a standardized questionnaire, which was sent to patients who underwent BR between November 2007 and August 2008. In addition to patients with SP, TE/SP, LD ± SP, or DIEP flap BR, patients who underwent LD+SP preceded by tissue expansion (LD+TE/SP) were also included. In case of two-stage procedures, extramural medical costs were analysed for both stages separately.

The questionnaire covered a two-month period. Four weeks after mailing the questionnaire, non-responders were sent a reminder. One month later, the remaining

non-responders were contacted by telephone. Patients who had undergone a two-stage procedure or respondents who had not yet fully returned to work were approached again after the second procedure or another two-month period, respectively. Written informed consent was obtained from all patients who were contacted.

Cost calculations

Medical costs were calculated by multiplying volumes of health care use with corresponding unit prices. For the most important intramural cost items, unit prices were determined by the hospital's financial department according to the micro-costing method.[15] Hospital salary schemes were used to estimate costs for personnel per hour.[16]

Costs of equipment included those of investment, depreciation, interest and maintenance. It was deemed unnecessary to specify equipment use per surgical technique. Costs for equipment and most materials were calculated per hour of operative time. Only costs for tissue expanders and implants were specifically allocated to operations.

Standard charges were used to calculate extramural medical costs and non-medical costs.[16] Productivity costs were only calculated for patients who had a job at the time of BR. Only non-medical costs associated with the initial breast mound reconstruction and short-term complications were considered.

Statistical analyses

Analyses were performed per patient on an intention-to-treat basis: costs of non-assigned treatments and complications were accounted to the initial treatment group. Costs are presented in Euros and apply to the financial year 2006, when 1 Euro equalized approximately 1.27 US dollar.[17] If appropriate, unit prices were converted using the Consumer Price Index that corrects for inflation. Discounting was not relevant because of the limited time horizon (mean follow-up 5.4 years).

To detect possible differences between different types of BRs, Pearson's Chi-square tests were used for categorical variables and Student's *t*-tests or non-parametric Mann Whitney *U*-tests for continuous variables. Subgroups were stratified by laterality (uni- or bilateral) and timing (primary or secondary) to allow accurate cost comparison between and within groups. Scatter plots and Spearman´s correlation coefficients were used to illustrate the relationship between medium-term costs and length of follow-up per patient. Two-tailed probabilities < 0.05 were accepted as statistically significant. Statistical analyses were performed using SPSS version 15.0 (SPSS Inc, Chicago, Ill).

RESULTS

Patient characteristics

We included 427 patients with primary or secondary BR using one of four techniques for the analysis of intramural medical costs. No patients were excluded due to incomplete medical files. Patient characteristics are presented in Table 1. Patients with SP or TE/SP

Table 1 | Characteristics of 427 patients who were included for a prospective historical cohort study of intramural medical costs of four different types of breast reconstruction.

	Overall (n = 427)	DIEP (n = 104)
General (mean; range)		
Age at time of BR (years)	45.3 (20.9 – 72.8)	47.4 (22.9 – 72.8)
Follow-up (years)	5.4 (1.4 – 8.5)	5.4 (3.6 – 7.5)
Breast reconstruction (n; %)		
Laterality		
Unilateral	257 (60)	76 (73)
Bilateral	170 (40)	28 (27)
Timing		
Primary (immediate)	239 (56)	21 (20)
Secondary (delayed)	187 (44)	83 (80)
Combination	1 (0)	0 (0)
Complications		
Neither short- nor medium-term	276(65)	77 (74)
Short-term	64 (15)	24 (23)
Medium-term	98 (23)	4 (4)[c]
Additional operations (n; %)		
Completed breast reconstruction*	339 (79)	88 (85)
Nipple (areola complex) reconstruction**	314 (93)	80 (91)
Outcome* (n; %)**		
Uncomplicated BR	422 (71)	110 (83)
Complicated BR (short- and/or medium-term)	133 (22)	18 (14)
Failed BR	42 (7)	4 (3)
Salvage with tertiary BR (i.e. ultimately successful)	27 (5)[d]	3 (2)[d]
No salvage	15 (3)	1 (1)

* Neo-breast with reconstructed nipple (areola complex). Patients who had undergone another additional operation to deal with complications or to improve the aesthetic result, but had refrained from further surgery one year after the last operation, were also included.

** Scored as a percentage of patients with a completed breast reconstruction process.

*** Scored per reconstructed breast, rather than per patient.

[a] Twenty-seven BRs were performed without an additional SP.

[b] Only one bilateral LD transposition was performed in one stage, 13 were performed in two stages.

LD ± SP (n = 116)	SP (n = 151)	TE/SP (n = 56)	p
50.2 (20.9 – 70.2)	42.4 (23.4 – 69.6)	39.2 (21.4 – 61.6)	< 0.001
5.6 (2.0 – 8.5)	6.3 (3.6 – 8.5)	2.7 (1.4 – 8.3)	< 0.001
102 (88)[a]	67 (46)	12 (21)	< 0.001
14 (12)[b]	84 (54)	44 (79)	
39 (34)	131 (87)	48 (86)	< 0.001
77 (66)	20 (13)	7 (13)	
0 (0)	0 (0)	1 (1)	
77 (66)	85 (56)	37 (66)	0.032
15 (13)	14 (9)	11 (20)	0.014
28 (24)	59 (39)	7 (16)	< 0.001
102 (88)	120 (79)	29 (52)	< 0.001
96 (94)	110 (92)	28 (97)	0.676
91 (70)	144 (61)	77 (77)	< 0.001
34 (26)	64 (27)	17 (17)	0.009
5 (4)	27 (11)	6 (6)	0.006
1 (1)[d]	21 (9)[d]	2 (2)[d]	< 0.001
4 (3)	6 (3)	4 (4)	0.439

[c] Abdominal herniation requiring surgical correction.

[d] Capsular contracture after implant BR was salvaged using either LD transpositions (n = 19) or TE/SP reconstructions (n = 2). One TE/SP reconstruction was salvaged using an LD transposition, another one using a DIEP flap. One failed implant after LD transposition was replaced after tissue expansion. Partial or total flap failure occurred in four DIEP flaps, requiring LD transposition (n = 3) and skin grafting (n = 1), respectively. Six implants were permanently removed after SP reconstructions, 4 after TE/SP reconstructions and 4 after LD transpositions.

reconstructions were significantly younger, underwent more bilateral and more primary BRs than patients with autologous reconstructions ($p < 0.001$). Short-term complications were more frequent in autologous reconstructions ($p = 0.014$), while medium-term complications, such as capsular contracture, implant displacement, or abdominal herniation mostly involved implants ($p < 0.001$). In 35 patients complications resulted in 42 failed reconstructions, of which 27 were salvaged using another type of BR.

In addition, seventy-six patients who had recently undergone BR were contacted for the prospective questionnaire study to assess extramural medical costs and direct and indirect non-medical costs. Response rate was 76%. Non-responders were equally divided over the subgroups and did not differ significantly from responders with regard to age or complication rate. Sixteen patients were contacted again as they reported that they had not fully returned to work two months after the operation.

Intramural medical costs

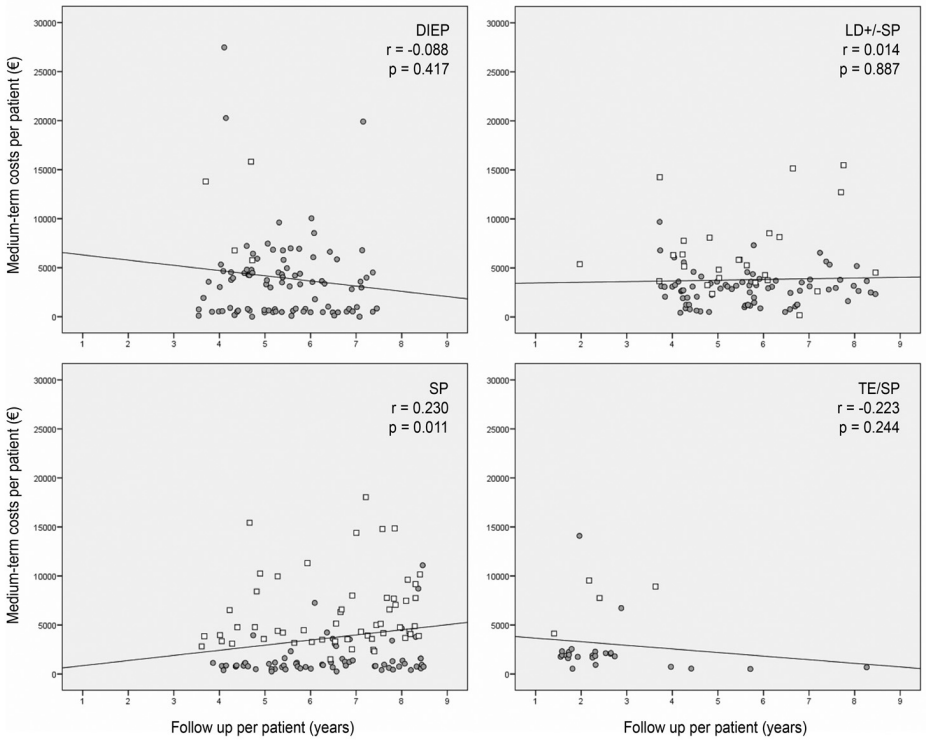
Tables 2 and 3 provide a detailed overview of all cost components, unit prices, and volumes of health care use, which were used to calculate costs. Table 2 focuses on mean costs of the standard initial operation, without incorporating re-operations due to short-term complications. Mean costs per patient differed significantly between techniques ($p < 0.001$), with DIEP flaps being most costly (unilateral €5,715; bilateral €8,388), followed by TE/SP (€4,832; €6,966), LD ± SP (€2,403; €5,589), and SP (€2,312; €3,621) reconstructions. Costs for personnel (related to duration of surgery) and material (predominantly use of implant material) were accountable for most of these differences.

Complications, re-operations, and additional operations to improve the aesthetic result are incorporated in Table 3, which presents short-term, medium-term, as well as total costs. Short-term costs for unilateral DIEP flaps (€12,848) and TE/SP reconstructions (€12,400) did not differ ($p = 0.792$), and were significantly higher than those for LD ± SP reconstructions (€5,804), which in turn were more expensive than SP reconstructions (€4,731). In bilateral cases, costs of TE/SP (€12,723) and LD ± SP (€10,760) reconstructions were comparable ($p = 0.136$), while DIEP flaps (€15,747) were significantly more expensive and SP reconstructions were significantly cheaper (€6,784). Costs for inpatient care and operations were the main causes for short-term cost differences.

Medium-term costs after DIEP flaps (€4,503; €3,778), LD ± SP (€3,757; €4,179), SP (€3,626; €3,879), and TE/SP reconstructions (€3,290; €3,017) did not differ significantly (unilateral $p = 0.551$, bilateral $p = 0.491$). Costs of medium-term complications could not be separated from those of additional operations aimed at improving the aesthetic result. When analysing patients without medium-term complications separately, additional costs were significantly higher after DIEP flap BR than after other types of BR (unilateral $p < 0.001$, bilateral $p = 0.013$). A major part of this difference, however, can be attributed to one unilateral patient, who suffered complications after an additional procedure, resulting in total medium-term costs of €27,476. Exclusion of this patient, however, did not change results.

Medium-term costs after SP reconstructions were significantly related to length of follow-up, with costs increasing over time ($r = 0.230$, $p = 0.011$; Figure 1).

Figure 1 | Scatterplot showing the relationship between medium-term costs per patient (€) and the follow-up per patient (years). The lines represent the fit line using the linear method. White squares: patients with additional operations dealing with complications; Gray circles: patients without additional operations dealing with complications.



r = Spearman's correlation coefficient (for the whole group)

Extramural medical costs and non-medical costs

Table 4 shows extramural medical and indirect medical and non-medical costs associated with the initial reconstruction. Costs related to absence from work (mean €9,081) accounted for approximately 98% of extramural medical and non-medical costs (mean €9,278). These costs did not differ between subgroups (p = 0.485).

Table 2 | Mean total costs per patient of standard initial breast mound reconstruction of four different breast reconstruction techniques, not considering re-operations due to complications. Detailed overview of cost components, unit prices, and volumes of health care use, which were used to calculate costs.

		DIEP (n = 80)			
		Unilateral (n = 61)		Bilateral (n = 19)	
Cost component	**Unit price (€)**	**Vol**	**Mean costs (€)**	**Vol**	**Mean costs (€)**
Personnel (hour)*					
Plastic surgery consultant	111	11.1	1,239	16.8	1,865
General surgery consultant	111	0.1	11	1.8	205
Anesthesiologist	111	3.7	413	5.6	622
Plastic surgery resident	44	7.4	324	11.2	487
Anesthesiology resident	44	7.4	324	11.2	487
Surgical assistants	196	7.4	1,452	11.2	2,186
Anesthesia personnel	109	7.4	809	11.2	1,218
Subtotal			**4,573**		**7,069**
Anesthesia					
Preoperative screening	62	1.0	62	1.0	62
Holding (preoperative)	20	1.0	20	1.0	20
Recovery (postoperative) (hour)	96	1.2	112	1.2	112
Anesthetics (hour)	6	7.4	47	11.2	71
Subtotal			**241**		**265**
Operating room including equipment (hour)**	41	7,4	**305**	11.2	**459**
Material					
Tissue expander	681	0.0	0	0.0	0
Silicone prosthesis	367-677	0.0	0	0.0	0
Other	412	1.0	412	1.0	412
Subtotal			**412**		**412**
Sterilization	94	1,0	**94**	1.0	**94**
Miscellaneous					
Laundry	35	1.0	35	1.0	35
Pharmacy	8	1.0	8	1.0	8
Medical photography	44	1.0	44	1.0	44
Subtotal			**88**		**88**
Mean total costs of standard breast reconstruction			**5,715**		**8,388**

* Consultants and residents were allocated to operations in line with common surgical planning. DIEP flap BR was performed by 1.5 plastic surgeons to facilitate a two-team approach; all other types of BR were performed by one. In general, the surgical team consisted of one staff surgeon and one plastic surgery resident. On average, anaesthesiologists were present during 50% of the operation. One anaesthesiology resident was present during the entire operation.

LD ± SP (n = 102)				SP (n = 137)				TE/SP (n = 45)			
Unilateral (n = 89)[a]		Bilateral (n = 13)[b]		Unilateral (n = 62)		Bilateral (n = 75)		Unilateral (n = 9)		Bilateral (n = 36)	
Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)
2.0	217	4.6	509	1.3	143	2.2	243	3.0	335	4.2	468
0.4	45	2.3	254	0.6	70	1.4	156	0.7	73	1.1	126
1.0	109	2.3	255	0.6	71	1.1	121	1.5	167	2.1	234
2.0	85	4.6	199	1.3	56	2.2	95	3.0	131	4.2	183
2.0	85	4.6	199	1.3	56	2.2	95	3.0	131	4.2	183
2.0	382	4.6	894	1.3	251	2.2	427	3.0	589	4.2	822
2.0	213	4.6	498	1.3	140	2.2	238	3.0	328	4.2	458
	1,138		**2,811**		**786**		**1,374**		**1,754**		**2,473**
1.0	62	1.9	119	1.0	62	1.0	62	2.0	124	2.0	124
1.0	20	1.9	39	1.0	20	1.0	20	2.0	41	2.0	41
1.2	112	2.2	215	1.2	112	1.2	112	2.3	224	2.3	224
2.0	12	4.6	29	1.3	8	2.2	14	3.0	19	4.2	27
	207		**403**		**202**		**209**		**408**		**415**
2.0	**80**	4.6	**188**	1.3	**53**	2.2	**90**	3.0	**124**	4.2	**173**
0.0	0	0.0	0	0.0	0	0.0	0	1.0	681	2.0	1,362
0.7	384	2.0	1,044	1.0	677	2.0	1,354	1.0	677	2.0	1,354
1.0	412	1.9	792	1.0	412	1.0	412	2.0	824	2.0	824
	796		**1,836**		**1,089**		**1,766**		**2,182**		**3,539**
1.0	**94**	1.9	**182**	1.0	**94**	1.0	**94**	2.0	**189**	2.0	**189**
1.0	35	1.9	68	1.0	35	1.0	35	2.0	71	2.0	71
1.0	8	1.9	16	1.0	8	1.0	8	2.0	16	2.0	16
1.0	44	1.9	85	1.0	44	1.0	44	2.0	89	2.0	89
	88		**169**		**88**		**88**		**176**		**176**
	2,403		**5,589**		**2,312**		**3,621**		**4,832**		**6,966**

** Operative times were calculated from the beginning of induction until recovery, and therefore do not solely reflect surgical time. For primary reconstructions, surgical time needed for mastectomy was included.

Table 3 | Mean total costs per patient for the entire breast reconstruction process of four different techniques, subdivided in short-term costs (initial breast reconstruction and short-term complications (< 6 weeks)) and medium-term costs (additional operations and medium-term complication (> 6 weeks))**.**

		DIEP (n = 104)			
		Unilateral (n = 76)		Bilateral (n = 28)	
Short-term costs	**Unit price (€)**	**Vol**	**Mean costs (€)**	**Vol**	**Mean costs (€)**
Outpatient care					
Visit to outpatient clinic	54-101	6.20	542	6.68	565
Visit to emergency room	205	0.05	11	0	0
Subtotal			**553**		**565**
Inpatient care*					
Hospital day – regular ward – complex care	562	3.00	1,685	3.00	1,685
Hospital day – regular ward – normal care	425	8.09	3,436	7.43	3,155
Hospital day – ICU	1,394	0.07	92	0.14	199
Hospital day – same day admission unit	300	0.01	4	0	0
Consultations	205	0.20	27	0.32	60
Subtotal			**5,244**		**5,099**
Surgery					
Inpatient operations – standard initial reconstruction**	2,312-8,388	1.00	5,715	1.00	8,388
Inpatient operations – short-term complications	variable	0.29	631	0.29	642
Outpatient operations	176	0	0	0	0
Subtotal			**6,346**		**9,013**
Diagnostics					
Radiology	35-462	1.64	202	1.89	222
Pathology	128-311	0.83	113	1.21	162
Laboratory and microbiology	variable	9.06	285	13.4	486
Subtotal			**600**		**870**
Physiotherapy	41	1.45	**61**	1.39	**57**
Miscellaneous	variable		**44**		**143**
Mean total short-term costs			**12,848**		**15,747**

LD ± SP (n = 116)				SP (n = 151)				TE/SP (n = 56)			
Unilateral (n = 102)		Bilateral (n = 14)		Unilateral (n = 67)		Bilateral (n = 84)		Unilateral (n = 12)		Bilateral (n = 44)	
Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)
7.00	588	14.5	1,206	5.61	478	5.25	452	13.67	1,135	14.1	1,161
0.03	6	0.07	15	0.03	6	0.05	10	0.17	34	0.20	42
	594		**1,220**		**484**		**462**		**1,170**		**1,203**
0.00	0	0	0	0	0	0	0	0	0	0	0
5.01	2,128	7.79	3,306	3.63	1,540	4.89	2,078	10.00	4,247	7.82	3,320
0.03	41	0	0	0	0	0.01	17	0	0	0	0
0.06	18	0.07	21	0.03	9	0.04	11	0.08	25	0.34	102
0.09	3	0	0	0	0	0.06	4	0	0	0.02	5
	2,189		**3,328**		**1,549**		**2,109**		**4,272**		**3,427**
1.00	2,403	1.00	5,589	1.00	2,312	1.00	3,621	1.00	4,832	1.00	6,966
0.20	356	0.10	213	0.06	106	0.17	285	0.50	1,798	0.39	895
0	0	0	0	0.01	4	0.04	9	0	0	0	0
	2,759		**5,802**		**2,421**		**3,915**		**6,630**		**7,861**
0.16	37	0	0	0.01	1	0.13	11	0.67	63	0.05	2
0.47	73	1.64	223	1.04	166	1.13	160	1.08	142	1.05	134
4.02	93	4.50	71	2.97	51	2.93	68	5.50	107	4.07	73
	202		**294**		**218**		**238**		**295**		**198**
1.37	**57**	2.71	**112**	1.43	**59**	1.43	**59**	0.33	**14**	0.36	**15**
	3		**5**		**1**		**1**		**6**		**7**
	5,804		**10,760**		**4,731**		**6,784**		**12,400**		**12,723**

Continued Table 3 | Mean total costs per patient for the entire breast reconstruction process of four different techniques, subdivided in short-term costs (initial breast reconstruction and short-term complications (< 6 weeks)) and medium-term costs (additional operations and medium-term complication (> 6 weeks))**.**

		DIEP (n = 88)			
		Unilateral (n = 61)		Bilateral (n = 27)	
Medium-term costs	**Unit price (€)**	**Vol**	**Mean costs (€)**	**Vol**	**Mean costs (€)**
Outpatient care					
Visit to outpatient clinic	54-101	5.49	472	5.52	466
Visit to emergency room	205	0.05	10	0.11	23
Subtotal			**482**		**489**
Inpatient care					
Hospital day – regular ward – normal care	425	4.43	1,880	2.96	1,258
Hospital day – ICU	1,394	0	0	0	0
Hospital day – same day admission unit	300	0.11	34	0.26	78
Consultations	205	0.34	20	0.04	2
Subtotal			**1,934**		**1,338**
Surgery					
Inpatient operations	1,227-2,663	0.92	1,791	0.85	1,600
Outpatient operations	176-196	0.67	178	0.85	279
Subtotal			**1,969**		**1,878**
Diagnostics					
Radiology	35-216	0.38	36	0.11	11
Pathology	128-311	0.23	29	0.22	28
Laboratory and microbiology	variable	2.52	49	2.04	33
Subtotal			**116**		**72**
Physiotherapy	41	0	**0**	0	**0**
Miscellaneous	variable		**3**		**1**
Mean total medium-term costs			**4,503**		**3,778**
Mean total costs of entire breast reconstruction process			**17,351**		**19,525**

* Patients undergoing implant breast reconstruction or LD transpositions were typically admitted on the day of surgery, DIEP flap patients the day before. DIEP flaps were monitored intensively on the regular ward during 3 postoperative days, reflected in 'complex care'.

** Mean total costs per patient of standard initial breast mound reconstruction, as specified in Table 2.

LD ± SP (n = 102)				SP (n = 120)				TE/SP (n = 29)			
Unilateral (n = 88)		Bilateral (n = 14)		Unilateral (n = 48)		Bilateral (n = 72)		Unilateral (n = 5)		Bilateral (n = 24)	
Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)	Vol	Mean costs (€)
9.13	778	9.29	784	8.46	731	8.33	718	4.40	379	4.13	349
0.09	19	0.14	29	0.15	30	0.08	17	0.20	41	0.13	26
	796		**813**		**761**		**735**		**420**		**375**
1.76	748	1.86	789	1.63	690	1.08	460	1.60	679	1.21	513
0	0	0	0	0	0	0.03	39	0	0	0	0
0.67	201	1.14	343	0.69	206	0.99	296	0.80	240	1.00	300
0	0	0	0	0	0	0	0	0	0	0	0
	949		**1,132**		**896**		**795**		**920**		**813**
1.07	1,743	1.14	1,916	0.85	1,726	0.97	2,089	1.00	1759	1.13	1750
0.67	160	0.86	246	0.73	173	0.79	226	0.60	160	0.17	53
	1,903		**2,162**		**1,899**		**2,315**		**1,919**		**1,803**
0.46	7	0.07	14	0.08	4	0.08	10	0	0	0	0
0.52	67	0.07	9	0.25	36	0.01	2	0	0	0	0
1.54	28	2.36	43	1.35	24	0.92	19	1.6	31	1.5	27
	102		**66**		**64**		**31**		**31**		**27**
0.08	**4**	0.07	**3**	0.10	**4**	0.08	**3**	0	**0**	0	**0**
	3		**3**		**1**		**1**		**0**		**0**
	3,757		**4,179**		**3,626**		**3,879**		**3,290**		**3,017**
	9,561		**14,939**		**8,357**		**10,663**		**15,690**		**15,740**

Table 4 | Extramural medical costs and non-medical costs associated with the initial breast reconstruction per patient. In case of two-stage procedures (TE/SP, LD + TE/SP), costs were calculated for both stages separately.

			Overall (n = 58)	DIEP (n = 21)	LD, LD+TE (1st stage), or LD+SP (n = 9)	TE (1st stage) (n = 16)	SP (2nd stage) (n = 12)	MWU
	Parameter	Unit price (€)	Mean costs (€)	Mean costs (€)	Mean costs (€)	Mean costs (€)	Mean costs (€)	p
Extramural medical costs								
General practitioner	visit	11-42	15	20	8	19	9	
Physiotherapist	visit	24	24	5	11	6	91	
In-home nursing care	hour	42	27	26	0	64	0	
Domestic help	hour	23	9	0	9	29	0	
Medication	dose	variable	24	24	26	26	21	
Subtotal			**100**	**74**	**54**	**144**	**121**	**0.673**
Non-medical costs								
Travel costs*	kilometre	variable	97	76	95	149	68	
			(n = 32)	**(n = 12)**	**(n = 3)**	**(n = 8)**	**(n = 8)**	
Absence from work**	hour	36	9,081	7,579	8,961	10,841	9,809	
Subtotal			**9,178**	**7,655**	**9,057**	**10,990**	**9,877**	**0.400**
Mean total costs			**9,278**	**7,729**	**9,111**	**11,134**	**9,998**	**0.485**

* Travel costs are based on the number of hospital visits as specified in the analysis of intramural medical costs. Travel distance from the hospital, way of transportation, and level of education did not differ between different types of breast reconstruction.

** Thirty-eight patients had a job at the time of their BR. Six patients, however, were not taken into account as they could not quantify their absence from work for various reasons.

DISCUSSION

This study evaluated economic implications of four BR techniques. Short-term intramural medical costs differed significantly, with DIEP flaps being most costly per patient (unilateral €12,848, bilateral €15,747), closely followed by TE/SP (€12,400; €12,723), LD ± SP (€5,804; €10,760), and SP reconstructions (€4,731; €6,784). Costs of unilateral DIEP flaps were comparable to unilateral TE/SP reconstructions, while bilateral LD transpositions, predominantly performed in two stages, were comparable to bilateral TE/SP reconstructions. Differences in short-term costs did not level out during follow-up (mean 5.4 years) and SP reconstructions remained the least expensive, costing on average €8,357 for a completed unilateral reconstruction and €10,663 for a bilateral one.

Single-stage SP reconstructions, however, are not suitable for all patients and many authors would only apply this technique in distinct situations, depending on the size and shape of the (contralateral) breast as well as the quality of chest wall soft tissues.[18] Radiation therapy and delayed reconstructions, amongst others, are considered contra-indications. Internationally there is a strong trend to expand overlying skin and muscle before placing the definite implant in order to improve the aesthetic result and reduce the risk for capsular contraction.[19-21] Only one of the authors (RTJW) has a vast personal experience with directly placing permanent implants, while the others (MAMM, SOPH) prefer to use tissue expanders. At our institution, implant BR is currently always preceded by tissue expansion. As expected, two-stage procedures resulted in higher costs than one-stage procedures.

Costs of the standard initial breast mound reconstruction differed significantly between unilateral and bilateral TE/SP reconstructions (€ 4,832 and €6,966, respectively (Table 2)). This difference is obviously due to the use of a second tissue expander and silicone prosthesis and longer operating times. However, when complications are taken into account, mean total short-term costs are similar (unilateral €12,400; bilateral €12,723 (Table 3)). Out of 12 unilateral TE/SP reconstructions, 3 patients sustained short-term complications requiring one tertiary DIEP flap BR, compared to 8 out of 44 bilateral reconstructions requiring one tertiary LD + TE/SP reconstruction. Due to the relatively small number of unilateral cases, these short-term complications had a very clear impact on volumes of health care use and, consequently, total short-term costs: operating times became comparable (unilateral 4.7 hours; bilateral 4.9 hours) and hospital admittance was even longer (10.0 days; 7.8 days). Also, relatively more additional tissue expanders and silicone prostheses were used after unilateral than after bilateral reconstructions (7 and 11 implants, respectively). BR practice is subject to change. Current practice and subsequently its costs have already evolved from the situation presented here. The awareness raised by this study has already changed protocols. Patients are more liberally discharged with drains, which is primarily of financial benefit to autologous BRs. Also, LD transpositions are increasingly combined with tissue expansion, which was not incorporated in this study, but will predictably result in higher costs.

Timing of BR has an effect on overall costs. Even though our data did not allow accurate assessment of this effect, it was estimated by relating cost differences between primary and secondary reconstructions to costs of a separate mastectomy. For correct comparison, costs of mastectomy have to be added to those of secondary BR. In our study,

primary reconstructions were generally more costly than secondary reconstructions (range €847 – €2,598; data not shown). In most cases these differences did not exceed costs of mastectomy, which were estimated to be €2,500, assuming that surgery takes one hour and patients are admitted for three days. These results support previously reported economic benefits of direct over delayed reconstructions, in addition to obvious personal benefits to the patient.[3,12,22] In our setting, primary BR is mostly performed in genetically predisposed patients undergoing prophylactic mastectomies; therapeutic mastectomies are mostly followed by secondary breast reconstructions due to both logistic difficulties as well as a cautious attitude by referring oncologic breast surgeons.

Overall, medium-term costs were comparable between techniques and initial cost differences between autologous and implant reconstructions remained. DIEP flap patients underwent more costly additional operations than other patients. Patients who sustain autologous BR might be more demanding than those who undergo less invasive techniques and therefore pursue more additional operations to improve the aesthetic result. We expected cost differences to (start to) level out, as the incidence of capsular contracture or implant displacement after implant BR is high and steadily increases over time.[23] Also, symmetry problems due to changes in body weight and effects of gravity continue to develop later in life. Our follow-up period, however, was too short to incorporate all long-term complications. Longer follow-up is therefore required. Our medium-term results suggest an increase in additional costs after SP reconstructions over time, compared to more stable long-term costs after other types of BR.

Longer recovery times and therefore higher productivity costs were anticipated after DIEP flap BR, while patients with implant BR were expected to return to work earlier. Surprisingly, patients returned to work approximately 10 weeks after surgery, regardless of type of BR. These recovery periods are comparable to those reported previously.[8] Our data suggest that overall recovery period is longer after a two-stage procedure than after a one-stage procedure, even if the latter is more complex. Incorporation of extramural medical costs into long-term cost-analysis would drastically change cost comparisons, especially since implant BR is increasingly preceded by TE. Sample size, however, might have been too small to detect differences. In addition, the Netherlands offers a very good social security system, which allows patients to take their time to return to work.

Our data were obtained from a group of surgeons with extensive experience with BR within a single, large university hospital in the Netherlands. Our results are therefore not directly transferable to other healthcare systems or less specialized surgeons. A teaching environment frequently mandates more medical staff to be involved than is common in general hospitals, rendering them more costly. By presenting our unit prices and volumes of health care use in great detail, we enable others to translate our results to their own situation and adjust for experience, composition of surgical team, or differences in technique. Costs of other types of BR, such as LD transpositions combined with tissue expansion, extended LD transpositions, S-GAP and TMG flaps, can be estimated if the most important volumes of health care use are known.

Ideally, costs should be related to a measure of benefit.[5-7,12] The most important outcome to measure the effectiveness of BR would be patient satisfaction and quality of life. Patient satisfaction after BR is generally high, but several studies reported higher satisfaction rates after autologous reconstructions.[24-26] This study focussed on presenting

costs in great detail. We are currently performing a prospective multi-centre study assessing patient satisfaction and the psychological impact of different types of BR using multiple questionnaires. Incorporating such data in a cost-analysis, rendering it a cost-utility analysis, would be the next step.

Instead of patient satisfaction, the occurrence of complications can be used as an alternative outcome measure. Kroll et al. determined cost-effectiveness by correcting costs for the ultimate success rate, which was defined as the percentage of patients who achieved successful BR, even if that required conversion to another technique.[5,12] In our population, BR was ultimately unsuccessful in only 11 out of 427 patients (15 out of 597 reconstructions). An additional 23 patients required salvage (27 reconstructions) and another 102 patients required one or more re-operations due to complications. Unfortunately, such complicated cases are not incorporated in Kroll's definition. Even though the number of complicated and salvaged reconstructions is significantly higher after implant BR, the number of failed reconstructions is comparable to other types of BR. Correcting costs for the ultimate success rate does therefore not change results drastically.

Differences in methodology and local (financial) situation complicate direct comparison of our results to those of previous studies. In some studies different types of BR (e.g., TE/SP and SP) were analysed together,[4,5,10] while others only presented standard treatment costs, disregarding costs caused by complications.[3,27] After converting all costs to 2006 Euros, our mean total costs for SP, TE/SP, and DIEP flap reconstructions were comparable to those reported by Kroll.[5] In addition to directly comparing costs, volumes of health care use can also be compared, thus bypassing differences in unit prices, charges or fees. Operative times were comparable to those reported in the literature,[1,4,5,22,27] but hospital admission after free flap surgery was (slightly) longer.[1,22,27] In our hospital, free flap patients are normally not discharged until all wound drains have been removed and patients have mobilized sufficiently. Especially in North America, discharge has been reported after 3 to 4 days.[1] Clearly, such differences in policy have a major effect on costs.

CONCLUSION

Short-term costs for unilateral DIEP flaps and TE/SP reconstructions were significantly higher than those for LD ± SP and SP reconstructions. In bilateral cases, costs of TE/SP and LD ± SP reconstructions were comparable, while DIEP flaps were significantly more and SP reconstructions significantly less expensive. Overall, medium-term costs were comparable between techniques and initial cost differences did not level out. However, longer follow-up is required. In current practice, definite implant placement is increasingly preceded by tissue expansion at more comparable costs to autologous BR. Subsequent incorporation of non-medical costs would further render two-stage procedures more costly than autologous BR.

In addition to understanding the medium-term economic complications of BR from a societal perspective, professional assessment of the technical feasibility, acceptable risks, and obtainable aesthetic result of different techniques will always remain of paramount importance to determine which technique is best suited for an individual patient. To achieve the optimal result, careful patient selection is critical, especially in case of single-

stage SP reconstruction. Only in select cases where two options are equally applicable, cost comparison becomes a valid argument for treatment selection.

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Patients' preferences for breast reconstruction: a discrete choice experiment

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ABSTRACT

Background

Patients' preferences are important determinants in the decision for a specific type of breast reconstruction (BR). Understanding patients' considerations in the decision for a specific type of BR can contribute to further improve patient counselling. We explored patients' preferences for three BR modalities in a discrete choice experiment (DCE).

Methods

We approached 386 patients who previously underwent a therapeutic (n = 309) or prophylactic (n = 79) mastectomy, of whom 247 had also undergone a BR. These women were asked to choose between hypothetical BR profiles that were characterized by six treatment attributes: 1) material used for reconstruction; 2) number and duration of operations; 3) short- and 4) long-term complication rate; 5) aesthetic result; 6) waiting time. Relative importance of attributes and trade-offs patients were willing to make between them were analysed using a multinomial logit regression model.

Results

Overall response rate was 71%. All treatment characteristics proved important for patients' choices. Respondents generally expressed a preference for autologous material and an excellent aesthetic result, which had the biggest positive effect on preferences. Complication rates of 20 – 30% had a similar negative effect. In this DCE, free flap BR fitted in best with patients' preferences.

Conclusions

Our study provides insight into the relative weight patients place on various aspects of BR and trade-offs they make between BR characteristics. In addition to understanding patient's considerations, professional assessment of the technical feasibility, acceptable risks, and obtainable aesthetic result of different techniques will always remain crucial to decide which technique is best suited for an individual patient.

INTRODUCTION

Breast reconstruction (BR) is aimed at restoring patients' quality of life and body image after mastectomy, and increasingly becomes an integral part of breast cancer (BC) treatment. Multiple techniques are available, differing in characteristics such as material used, duration of the operation(s), recovery period, complication rates, and aesthetic result. Each technique has (dis)advantages and therefore its own place in current practice.[1]

Multiple factors have to be considered to determine the optimal treatment modality for individual patients. Procedural characteristics have to be regarded in the context of patient-related factors (e.g., age, medical history, body habitus) and surgeon-related factors (e.g., expertise, experience) to assess which methods are technically feasible and which risks acceptable. Adjuvant radiation therapy, for example, is a relative contra-indication for implant BR due to increased complication rates, while sufficient excess abdominal tissue is a prerequisite for autologous BR using abdominal tissue.[2,3]

Complementary to the medical analysis performed by the plastic surgeon regarding which BR type individual patients could undergo, patients' preferences for the procedure they would opt for are also important determinants of the treatment choice. Understanding women's motivational factors and personal views can contribute to further improve patient-centred and demand-led healthcare.

The aim of this study was to explore patients' preferences for different BR modalities after (prophylactic) mastectomy using a discrete choice experiment (DCE). We also evaluated whether preferences differed between patients who had or had not undergone a BR and between women with or without a genetic predisposition to develop BC.

PATIENTS AND METHODS

Breast reconstruction

There are essentially three types of BR after mastectomy, using implant material, autologous tissue, or a combination of both.[1] At our university hospital in Rotterdam, the Netherlands, which includes the Daniel den Hoed Cancer Centre (DdHCC), the most frequently performed methods per category are: implants preceded by tissue expansion (TE), free deep inferior epigastric perforator (DIEP) flap, and pedicled latissimus dorsi (LD) flap combined with an implant, respectively. BR can be performed directly after mastectomy (primary BR) or at a later stage (delayed or secondary BR).

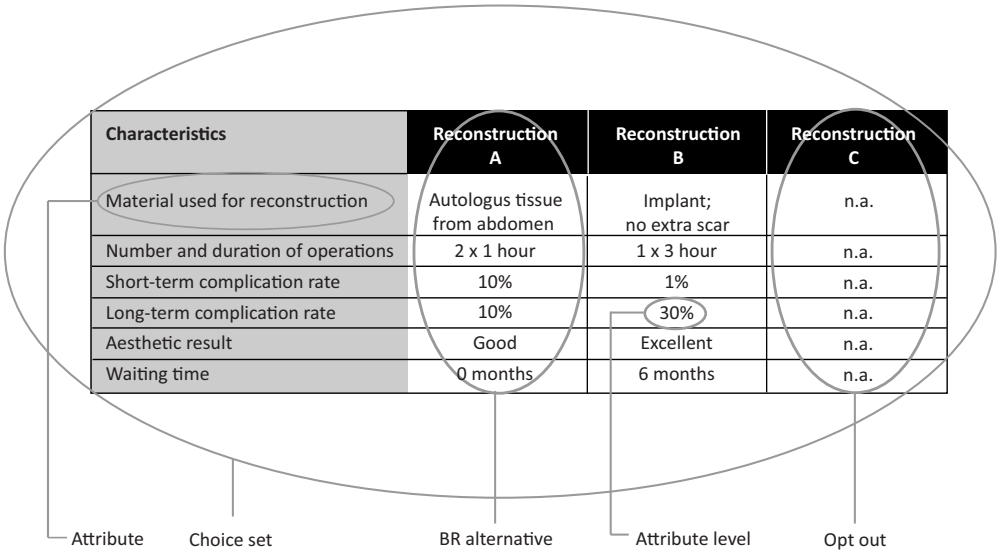
The DdHCC specifically attracts patients with a genetic predisposition to develop BC (due to a BRCA 1/2 mutation), who frequently opt for prophylactic bilateral mastectomy. In the Netherlands, BR is covered by basic health insurance and no out-of-pocket expenses are required from patients.

Discrete Choice Experiment (DCE)

DCEs constitute a formal methodology to evaluate respondents' preferences, which are increasingly being used in healthcare to explore trade-offs that patients make between

different treatment modalities.[4-6] In this context, application of DCEs assumes that healthcare interventions can be characterized by a combination of attributes and attribute levels, and that this combination determines patient preferences.[4] In a DCE, respondents are repetitively offered hypothetical choices between alternative treatments, which are presented as different combinations of attribute levels. The relative importance of attributes can be assessed by analysing the trade-offs patients make between attributes and attribute levels.[7] The concept of DCE and its definitions are illustrated in Figure 1.

Figure 1 | Concept of discrete choice experiments illustrated using a choice set as presented in questionnaire. Nine different choice sets were presented to each respondent, each consisting of two BR alternatives (A and B) and a 'no reconstruction' option (C) to allow patients to 'opt out'. BR alternatives were characterized by six attributes, which in turn had three possible attribute levels. Some random combinations of attribute levels cannot be related to an actual technique. Patients were instructed to consider these hypothetical options as realistic alternatives and to choose the option that appealed most to them.



n.a. = not applicable

Attributes and attribute levels

Choice of attributes and their levels was based on data from literature and interviews with specialists and women having had a mastectomy or BR.[2,3,8-11] Six attributes were selected: 1) material used for reconstruction; 2) number and duration of operations; 3) short- and 4) long-term complication rate; 5) aesthetic result; 6) waiting time.

Three levels were determined per attribute. Some hypothetical levels were included to allow assessment of preferences to be extended beyond currently available treatments and to potentially guide the development of new techniques (Table 1).

Table 1 | Six attributes with three levels each used for discrete choice experiment to assess women's preferences for three different types of breast reconstruction. The sign of the coefficient reflects whether the attribute has a positive or negative effect on utility, the value indicates the relative importance of the attribute to total relative utility. A statistically significant coefficient indicates that respondents considered that attribute important.

Attributes and levels	Coefficient in regression analysis		p
Constant (breast reconstruction)	β_0	0.20	0.05
Material used for breast reconstruction			
Implant	β_1	0.33	< 0.01
Autologous tissue from abdomen	β_2	0.76	< 0.01
Autologous tissue from back with implant	*		
Number and duration of operation(s)			
1 x 3 hours	*		
2 x 1 hour	β_3	-0.21	< 0.01
1 x 7 hours	β_4	-0.49	< 0.01
Short-term complication rate	β_5	-0.43	< 0.01
1 percent			
5 percent			
10 percent			
Long-term complication rate	β_6	-0.30	< 0.01
0 percent			
10 percent			
30 percent			
Aesthetic result			
Moderate	*		
Good	β_7	0.82	< 0.01
Excellent	β_8	1.18	< 0.01
Waiting time	β_9	-0.01	0.05
0 months			
6 months			
12 months			

* 'Autologous tissue from back with implant', '1 x 3 hour surgery', and 'moderate aesthetic result' are used as points of reference (base levels).

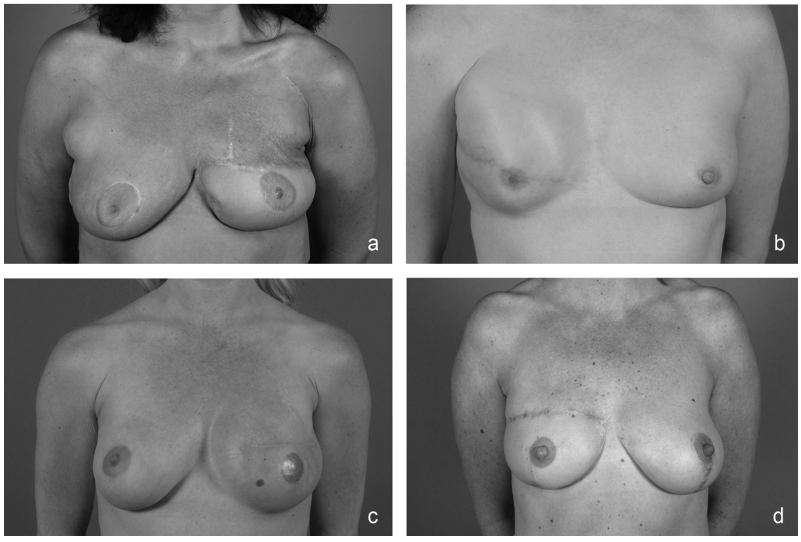
Study design and questionnaire

The combination of attributes and attribute levels (6 attributes with 3 levels each) resulted in 729 (3^6) hypothetical BR alternatives, which, for obvious practical reasons, could not all be used in a questionnaire. A sample of eighteen BR alternatives proved sufficient to estimate all main effects in a regression analysis.[12,13] Choice sets were subsequently designed and consisted of two BR alternatives and a 'no reconstruction' option to allow patients to 'opt out' (Figure 1).[14] BR is elective surgery and patients should not be forced to choose BR.

Previous studies demonstrated that more than 16 choice sets per respondent are associated with lower response rate and/or response reliability.[15,16] Therefore, 18 choice sets were divided over two questionnaires containing nine choice sets each (i.e., two questionnaires constituted one full dataset).[17]

Each questionnaire started with a detailed description of attributes and their levels. Pictures were included to demonstrate 'moderate' and 'excellent' aesthetic results (Figure 2). Short-term complications (e.g., infection, haematoma, or flap failure) were defined as arising within 6 weeks after BR, while long-term complications (e.g., capsular contracture, abdominal herniation) were stated to arise between 6 weeks and 5 years after BR. The questionnaire was specifically designed not to favour any type of BR. A dominant choice set (i.e., a choice set in which both alternatives used implant material, but one was characterized by logically preferable levels on all other attributes) was included to test for rationality.

Figure 2 | Pictures, which were provided to patients to illustrate moderate and excellent aesthetic results. a) Moderate result of DIEP flap, b) moderate result of implant breast reconstruction, c) excellent result of implant breast reconstruction, d) excellent result of DIEP flap.



The main part of each questionnaire comprised of nine choice sets. Patients were asked to consider all three options as realistic alternatives – even though some combinations of attribute levels cannot be related to an actual technique – and to choose the option that appealed most to them. Furthermore, eight questions covered medical history, satisfaction with previous BR, whether or not patients would opt for (the same type of) BR again, marital status, and level of education.

The questionnaire was pilot tested (n = 10) to check for problems in interpretation and face validity. As none of the respondents raised any problems, no alterations were made.

A more detailed and technical description of the study design is available from the authors upon request.

Study sample

We randomly approached 386 women from a total group of 820 who had undergone a mastectomy with (n = 247) or without (n = 139) BR between 2002 and 2006 in our hospital. The vast majority of patients had been diagnosed with sporadic BC (n = 309). Seventy-nine patients were genetically predisposed to develop BC due to a BRCA 1/2 mutation and had chosen to undergo a contralateral or bilateral prophylactic mastectomy. None of the respondents had signs of BC recurrence at the time of the study. Women over 70 years of age were not eligible.

The numbers of respondents, choices per respondent, and attributes and attribute levels determine the power of a DCE. A formal power analysis is not feasible, however, as patients' preferences are hard to predict. Earlier studies have shown that the sample size of our study is sufficient for reliable statistical analyses.[4,8]

Procedure

The questionnaire and a prepaid return envelope were mailed to 386 patients. After 4 weeks non-responders were sent a reminder and after two months remaining non-responders were contacted by telephone. Written informed consent was obtained from all patients. The study was approved by the medical ethical review committee (MEC-2007-406).

Statistical analyses

Differences in age were analysed using Student's *t*-tests for independent samples, while differences in categorical variables were analysed using Pearson chi-square tests.

The DCE was analysed taking each choice among the three options as an observation. Data from respondents who failed the dominant question were excluded from further analysis. Remaining observations were analysed by a multinomial logit regression model to determine the relative importance of treatment attributes. This model was implemented in SAS software (Version 9.1, SAS Institute Inc., Cary, NC, USA). Assuming that all attributes have an independent influence on women's preferences, the following model was estimated (Equation 1):[13]

$V = \beta_0 + (\beta_1 * \text{implant}) + (\beta_2 * \text{autologous tissue from abdomen}) + (\beta_3 * (2x1 \text{ hour operations})) + (\beta_4 * (1x7 \text{ hour operation})) + (\beta_5 * \text{short-term complications}) + (\beta_6 * \text{long-term complications}) + (\beta_7 * \text{good aesthetic result}) + (\beta_8 * \text{excellent aesthetic result}) + (\beta_9 * \text{waiting time})$

Where:

- V represents total relative utility derived from a certain type of BR, which can be viewed as the preference for that particular health state;[19]
- β_0 is a constant reflecting respondents' preference for receiving BR relative to 'no BR';
- β_1 to β_9 are coefficients indicating the relative importance of each attribute or attribute level; β_1 to β_4, β_7 and β_8 are dummy variables of 'material used', 'duration of operation(s)', and 'aesthetic result', with 'autologous tissue from the back with implant' as base level for β_1 and β_2, '1x3 hour operation' as base level for β_3 and β_4, and 'moderate aesthetic result' as base level for β_7 and β_8;
- short- and long-term complication rates are scored as a fraction of 10%;
- waiting time is scored in months;
- and β_5, β_6, and β_9 are continuous.

Relative utility scores, which equal the sum of coefficient weights of attribute levels, allow comparison of strengths of preferences for specific BR types. The higher a relative utility score, the stronger the preference for that particular BR alternative. Absolute values of V, however, have no direct interpretation.[13]

The *sign* of a coefficient reflects whether the attribute has a positive or a negative effect on utility, and the *value* of a coefficient indicates the relative importance of the corresponding attribute to total relative utility. A *statistically significant* coefficient is interpreted to indicate that respondents considered the attribute important. A priori all attributes were expected to be important, and aesthetic result and autologous material were expected to have a positive effect.

When realistic attribute levels are implemented in Equation 1, relative utility scores of actual BR techniques can be generated and subsequently ranked, even if that procedure was not directly studied in this DCE (e.g., extended latissimus dorsi transpositions which do not require additional implants).

Trade-offs that respondents are willing to make between attributes can be estimated by the ratios of the coefficients. For example, β_2/β_9 estimates how much longer respondents are willing to wait (in months) to undergo autologous BR instead of BR with autologous tissue and an implant.

Subgroup analyses were conducted using interaction terms in the regression model to assess if preferences of patients who previously underwent BR differed from those who had not. We also compared patients who had undergone BR after sporadic BC to genetically predisposed patients who had undergone BR.

RESULTS

Respondents

Of 386 invited patients, 320 responded and 272 agreed to participate (overall response rate: 71%). Respondents' characteristics are presented in Table 2. Table 3 gives an overview of the experiences of 186 respondents who underwent BR.

DCE results

In total, 270 of 272 patients (99%) passed the dominant question, demonstrating their understanding of the DCE task. Coefficients for all treatment attributes were significant (i.e., all attributes had a significant effect on preferences) and all signs of coefficients were in keeping with a priori expectations (Table 1). The positive constant term suggests that respondents generally had a positive attitude towards BR. Respondents preferred autologous tissue over implants, while autologous tissue combined with an implant was least popular (i.e., β_1 and β_2 were both positive in comparison to base level, while β_2 was more positive than β_1). A short operation was preferred over a long operation and patients would rather undergo two short operations than one long one. Patients were less likely to choose options with increasing complication rates, both short- and long-term. Short-term complications were more important than long-term complications (β_5 was more negative than β_6). An 'excellent' aesthetic result was preferred over 'good' or 'moderate'.

The magnitude of attribute coefficients corresponds with their relative importance and effect on preferences. Coefficients for autologous material and an excellent aesthetic result were the highest (0.76 and 1.18, respectively; Table 1), but those for complications were scored per 10%. Consequently, a short-term complication rate of 20% would have a similar negative effect on utility (-0.43 * 2 = -0.86), as would a 30% long-term complication rate (-0.30 * 3 = -0.90).

Most respondents were willing to make trade-offs between attributes with a positive and a negative effect on utility. An excellent aesthetic result, for example, would be traded for a good one (utility difference equals 0.82 – 1.18 = -0.36) in exchange for a 10% decrease in short-term complication rate (utility 0.43). Similarly, patients would theoretically be willing to wait 76 months to undergo autologous BR instead of BR with autologous tissue and an implant (β_2/β_9 = 0.76/-0.01). Only 27% of respondents who previously underwent BR were not willing to make a trade-off with regard to the material used for BR and consistently chose the same material, which in over 90% matched their own BR type, or opted out (data not shown).

The results of subgroup analyses are presented in Table 4. Patients with a BR had a significantly more positive attitude towards BR in general than women without a previous BR (1.43 vs. -1.44; $p < 0.01$). Except for women without BR having a significantly stronger preference for autologous tissue (1.28 vs. 0.67; $p < 0.01$), there were no differences between both groups. Of patients who had undergone BR, preferences of those with and without a genetic predisposition were also very similar. Mutation carriers only expressed more disutility from long-term complications than those without a genetic predisposition (-0.47 vs. -0.25; $p < 0.01$).

Table 2 | Respondents' characteristics. Differences were analysed between patients who did and did not undergo breast reconstruction and between patients with and without a genetic predisposition to develop breast cancer.

	All patients (n = 270)		Patients with BR (n = 186)		Patients without BR (n = 84)		p	Patients with BR, without genetic predisposition (n = 134)		Patients with BR, with genetic predisposition (n = 52)		p
	n	%	n	%	n	%		n	%	n	%	
Age (years)							< 0.01					< 0.01
20-29	2	0.7	2	1.1	0	0.0		1	0.7	1	1.9	
30-39	35	13.0	31	16.7	4	4.8		10	7.5	21	40.4	
40-49	72	26.7	57	30.6	15	17.9		40	29.9	17	32.7	
50-59	108	40.0	73	39.2	35	41.7		63	47.0	10	19.2	
60-69	53	19.6	23	12.4	30	35.7		20	14.9	3	5.8	
Genetic predisposition							< 0.01					
Yes	55	20.4	52	28.0	3	3.6		0	0.0	52	100.0	
Household							0.31					0.04
With partner	222	82.2	150	80.6	72	85.7		103	76.9	47	90.4	
Educational level							0.52					0.21
Low	98	36.3	65	34.9	33	39.3		52	38.8	13	25.0	
Intermediate	87	32.2	64	34.4	23	27.4		43	32.1	21	40.4	
High	85	31.5	57	30.6	28	33.3		39	29.1	18	34.6	

Table 3 | Characteristics and experiences of respondents who previously underwent breast reconstruction. Eighteen patients underwent more than one breast reconstruction, resulting in different totals. These patients were excluded from the subgroup analysis.

	All patients with BR (n = 186)		TE / implant (n = 70)		LD ± implant (n = 47)		DIEP, fTRAM (n = 49)		p
	n	%	n	%	n	%	n	%	
Type of BR									
Tissue expander, implant	87	42.6							
LD ± implant	60	29.4							
Abdominal autologous tissue (DIEP, fTRAM)	55	27.0							
Other	2	1.0							
Laterality of BR									< 0.01
Unilateral	99	53.2	21	30.0	38	80.9	34	69.4	
Bilateral	87	46.8	49	70.0	9	19.1	15	30.6	
Timing of BR									< 0.01
Immediate (primary)	85	45.7	50	71.4	16	34.0	9	18.4	
Delayed (secondary)	91	48.9	18	25.7	30	63.8	38	77.6	
Combination	10	5.4	2	2.9	1	2.1	2	4.1	
Complications (perceived)									< 0.01
Short-term complications	48	25.8	7	10.0	16	34.0	17	34.7	
Long-term complications	31	16.7	12	17.1	9	19.1	2	4.1	
Satisfaction with BR									< 0.01
Satisfied	118	63.4	32	45.7	33	70.2	41	83.7	
Reasonably satisfied	58	31.2	31	44.3	13	27.7	8	16.3	
Not satisfied	10	5.4	7	10.0	1	2.1	0	0.0	
Would opt for BR again									0.50
Yes	184	98.9	69	98.6	47	100.0	49	100.0	
If yes, would choose same BR procedure again									0.03
Yes	154	83.7	60	85.7	38	80.9	48	98.0	

fTRAM = free transverse rectus abdominis musculocutaneous flap

Table 4 | Differences in preferences for breast reconstruction between patients who did and did not undergo breast reconstruction and between patients with and without a genetic predisposition to develop breast cancer.

Attribute	Coefficient of patients with BR (n = 186)	Coefficient of patients without BR (n = 84)	p	Coefficient of patients with BR, without genetic predisposition (n = 134)	Coefficient of patients with BR, with genetic predisposition (n = 52)	p
Constant (breast reconstruction)	1.43	-1.44	< 0.01	1.19	1.79	0.08
Material used for reconstruction						
(base level: autologous tissue from back with implant)						
Implant	0.31	0.43	0.55	0.20	0.56	0.08
Autologous tissue from abdomen	0.67	1.28	< 0.01	0.83	0.60	0.32
Number and duration of operation(s)						
(base level: 1 x 3 hours)						
2 x 1 hour	-0.15	-0.45	0.11	-0.13	-0.20	0.75
1 x 7 hours	-0.49	-0.49	0.99	-0.38	-0.55	0.40
Short-term complication rate (per 10%)	-0.44	-0.39	0.80	-0.38	-0.74	0.13
Long-term complication rate (per 10%)	-0.30	-0.43	0.06	-0.25	-0.47	< 0.01
Aesthetic result						
(base level: moderate)						
Good	0.85	0.69	0.43	0.84	1.13	0.18
Excellent	1.27	1.12	0.45	1.25	1.66	0.08
Waiting time (per month)	-0.02	0.00	0.26	-0.01	0.00	0.71

The relative importance of attributes was subsequently used to estimate and compare relative utilities derived from different BR profiles (Table 5). In contrast to (relatively) fixed levels for material and duration of operation, levels for complication rates and aesthetic result are more variable and prone to discussion. The isolated effect of material and number and duration of operations on utility was therefore evaluated first by assuming equal complication rates (10%), aesthetic results (good), and waiting time (0 months) (Table 5, top lines of each section). As an example, utility derived by TE/implant BR can be calculated as follows: 0.20 + (0.33 * 1) + (0.76 * 0) - (0.21 * 1) - (0.49 * 0) - (0.43 * 1) - (0.30 * 1) + (0.82 * 1) + (1.18 * 0) - (0.01 * 0) = 0.41. Under these assumptions, the estimated relative utility score for DIEP flap BR was higher than those for TE/implants and LD transpositions with implants (0.56, 0.41 and 0.29, respectively).

The effect of changes in attribute levels on relative utilities and the subsequent ranking of different treatment scenarios are also presented. Realistic complication rates were applied.[20] It is shown, for example, that an increase in long-term complication rate from 10 to 30% would lower utility derived from TE/implant BR from 0.41 to -0.19. Similarly, performing an extended LD transposition without additional implant use would result in higher utility scores.

DISCUSSION

This discrete choice experiment showed that autologous material and an excellent aesthetic result were generally the most important determinants in women's choices for (a specific type of) BR and had the biggest positive effect on utility. However, short- and long-term complication rates of 20 and 30%, respectively, had a similar negative effect on utility.

Patients' motivation for and satisfaction with BR have been previously assessed, mostly focusing on general determinants of patients' preferences for BR and its timing.[21-24] These studies, however, did not distinguish between different types of BR, nor did they evaluate the impact of specific procedural characteristics on patients' choices in a formal DCE. This is the first DCE on BR.

Characteristics of subgroups with regard to age, genetic predisposition, complication rates, and patient satisfaction were in line with previous research. Patients who undergo a BR tend to be younger than patients who refrain from BR.[25,26] In addition, a BRCA mutation is generally recognized at a younger age than the mean age at which BC develops in the population, and women who opt for prophylactic mastectomy tend to request BR as well. The number of genetically predisposed patients in our study sample was high compared to normal practices, due to our specialized cancer clinic. Short-term complications are more frequent in autologous BR, while long-term complications (e.g., capsular contracture) are typical for implant reconstructions.[9]

Respondents who had undergone a LD transposition were least likely to state the same preference in the DCE. Our results showed that both implant material and autologous tissue were preferred over the combination of autologous tissue with an implant. These findings are in line with each other and demonstrate our study's (internal) validity.

In estimating the relative utilities for existing BR techniques (Table 5), we firstly used moderate complication rates of 10% to allow unbiased comparison of techniques.

Table 5 | Utility scores and ranks of several breast reconstruction profiles. The top line of each BR technique evaluates the isolated effect of material and number and duration of operation(s). The effect of changes in attribute levels on utility is evaluated in following lines. Realistic short- and long-term complication rates are indicated (*).[20]

Material used for BR	Number and duration of operation(s)	Short-term complications	Long-term complications	Aesthetic result	Waiting time	Relative utility score[a]	Rank
TE / implant							
Implant	2 x 1 hour	10%*	10%	Good	0	0.41	6
Implant	2 x 1 hour	10%*	20%	Good	0	0.11	10
Implant	2 x 1 hour	10%*	30%*	Good	0	-0.19	14
Implant	2 x 1 hour	10%*	30%*	Moderate	0	-1.01	15
Implant	2 x 1 hour	10%*	30%*	Excellent	0	0.17	9
LD ± implant							
Autologous + implant	1 x 3 hour	10%	10%	Good	0	0.29	7
Autologous + implant	1 x 3 hour	15%*	15%*	Good	0	-0.08	13
Autologous + implant	1 x 3 hour	15%*	15%*	Excellent	0	0.29	8
Autologous	1 x 3 hour	10%	10%	Good	0	1.05	1
Autologous	1 x 3 hour	15%*	5%*	Good	0	0.99	2
DIEP							
Autologous	1 x 7 hour	10%	10%	Good	0	0.56	3
Autologous	1 x 7 hour	25%*	5%*	Good	0	0.06	11
Autologous	1 x 7 hour	25%*	5%*	Excellent	0	0.43	5
Autologous	1 x 7 hour	25%*	5%*	Good	12	-0.06	12
Autologous	1 x 3 hour	25%*	5%*	Good	0	0.56	4

[a] Breast reconstruction utility = 0.20 + (0.33 * implant) + (0.76 * autologous) - (0.21 * 2 x 1 hour) - (0.49 * 1 x 7 hour) - (0.43 * short-term complication rate) - (0.30 * long-term complication rate) + (0.82 * good) + (1.18 * excellent) - (0.01 * waiting time)

In reality, however, complications rates are generally higher than 10% and differ strongly between techniques. Long-term complication rates after implant reconstructions have been reported to be as high as 40%.[9] Also, autologous reconstructions are frequently said to yield superior aesthetic results.[21] In our own experience, DIEP flap surgery can frequently be performed in less than five hours. Such changes in attribute levels have a major impact and drastically alter relative utility scores. In contrast, waiting time hardly affected utility levels.

In addition, the model presented here can be used to estimate relative utility scores of procedures that were not directly studied in this DCE. Extended LD transpositions, for example, offer the advantages of autologous tissue, while operation times are shorter than those of free flap BR and long-term complications associated with the use of implant material are avoided. Applying appropriate attribute levels for extended LD transpositions would result in superior utility levels compared to DIEP flap BR.

All patients in our study population had experienced mastectomy and a majority of patients had also undergone BR. All respondents were therefore able to identify themselves with the choices presented in the questionnaire, which is one of the prerequisites for a successful DCE. This design, however, is less suitable to predict actual choice behaviour, as in real life decisions had already been made. In contrast, a prospective design, using women who are about to undergo or have already undergone mastectomy and are currently deciding on BR, is less practical to assess patients' considerations, but does allow external validation of results by comparing stated preferences to actual behaviour.[27]

Patients who previously underwent BR are likely to incorporate their experiences in their answers and may even 'defend' their own choice and treatment (cognitive dissonance).[28] This mechanism could explain why patients who had not undergone a BR had an even stronger preference for autologous material than the total group of women with a BR. Respondents who previously had a positive experience with implant BR (nearly 60% of all respondents with a BR in our sample) are less likely to demonstrate a strong preference for autologous tissue, regardless of their original preferences. Nevertheless, only 27% of respondents who had experienced BR were not willing to make a trade-off with regard to material used and consistently chose the material that matched their own BR type, or opted out.

Patient satisfaction after BR is generally high, but several studies reported higher satisfaction rates after autologous reconstructions.[21,29] In our study sample, respondents who underwent autologous BR were indeed more satisfied than women who underwent other types of BR. Possibly, these women also expressed higher preferences for (autologous) BR compared to other respondents, which may have inflated the preferences for (autologous) BR. Statistical adjustment for 'previous BR type' would have been appropriate, but was technically not possible.

CONCLUSION

This DCE showed that patients' choices for BR after (prophylactic) mastectomy are influenced by material used for reconstruction, number and duration of operations, short- and long-term complication rates, aesthetic result, and waiting time. Autologous material

and aesthetic result had the biggest positive effect on utility, while complication rates of 20 – 30% had a similar negative impact. More insight into the relative weight patients place on various aspects of BR and the trade-offs they make between BR attributes enables healthcare workers to improve counselling. Professional assessment of technical feasibility, acceptable risks, and obtainable aesthetic result will always remain crucial to decide which technique is best suited for an individual patient.

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9

General discussion

This thesis addressed technical, psychological, and economic aspects of DIEP flap BR. In this chapter, the main findings regarding the objectives as outlined in the general introduction will be presented first. Subsequently, strengths and weaknesses of our methodological approach will be outlined and our results and conclusions will be discussed in the context of recent literature and current and future developments. This chapter ends with an overall conclusion and recommendations for future research and clinical practice.

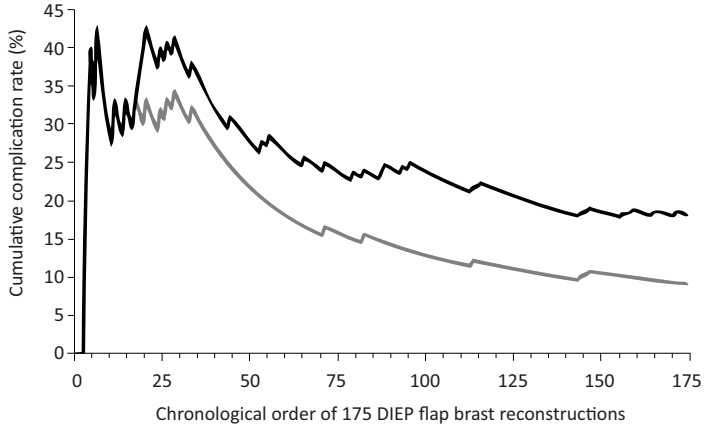
MAIN FINDINGS

Research question 1: What is the effect of the surgeon's learning curve, patient characteristics, and risk factors on the complication rate after DIEP flap BR?

The clinical outcomes of 175 consecutive DIEP flap BRs are presented in **chapter 2**. Our early experiences indicated that partial flap failure due to venous congestion was a returning problem; flap design was subsequently altered and contralateral zone 2 as defined by Hartrampf was more liberally excised.[1] Later in the series, other complications that resulted in changes to the protocol included mastectomy skin flap necrosis (periareolar instead of Wise pattern approach) and pulmonary embolisms (early mobilisation and pneumatic compression devices).

Critical assessment of intra- and postoperative problems showed a significant decrease in complications after the first 30 flaps performed in 23 patients. The complication rate dropped from approximately 40% to less than 15% (Figure 1). The latter percentage is comparable to that reported in literature.[2,3]

Figure 1 | Overview of cumulative complication rate during the course of our series of 175 consecutive DIEP flap breast reconstructions. The black line represents overall DIEP flap complication rate, the grey line (partial) flap failure rate.



This learning curve is appropriate for an experienced team of (micro)surgeons introducing a new perforator flap. By sharing our experiences and presenting our (adjusted) protocol, colleagues can learn from our mistakes and hopefully shorten their own learning curve.

We assessed the relationships between the occurrence of flap and donor-site complications and multiple risk factors and patient characteristics. No significant relationships were found between DIEP flap complications and smoking, diabetes, hypertension, excessive BMI (> 30 kg/m^2), pregnancy, previous radiotherapy or abdominal operations. There was a trend, however, indicating that smoking and diabetes had a negative effect on DIEP flap complications. The negative effect of smoking on (micro) surgical outcome has been extensively studied.[4] Abdominal complications were only significantly related to diabetes and hypertension, as was previously reported in regular abdominoplasties.[5]

Selection criteria for performing DIEP flap BRs in certain groups of patients have previously been proposed on the basis of patient comorbidities, such as smoking, diabetes, and obesity.[6] Current trends suggest free flap BR to be a safe application in patients previously felt to be unacceptable surgical candidates.[7] According to our data there is insufficient evidence to decline groups of patients DIEP flap BR based on risk factors. Our current policy is that all patients undergoing elective free flap BR are strongly advised to stop smoking 6 weeks prior to surgery. Smoking, however, is not a strict contra-indication. Obesity (BMI > 30 kg/m^2) is associated with an increased risk of pulmonary embolisms and wound healing problems.[8, 9] Therefore, in our hospital obese women must currently loose weight in order to be eligible for free flap BR.

Research question 2: Which algorithms can be developed to facilitate perioperative and intraoperative decision-making and increase the success rate of microsurgical breast reconstruction?

The successful outcome of microsurgical breast reconstruction largely depends on perioperative and intraoperative decisions with regard to flap choice, donor and recipient vessel selection, and early recognition and management of complications. In **chapter 3** we review a single surgeon´s experience with 406 microsurgical breast reconstructions, which were performed at the Erasmus MC, Rotterdam, Netherlands, and the University Health Network, Toronto, Canada. DIEP flaps comprised 88% (n = 359) of all flaps, while muscle-sparing (MS) and fascial-sparing (FS) transverse rectus abdominis musculocutaneous (TRAM) flaps comprised 11% (n = 44) and 1% (n = 3), respectively. Of all DIEP flaps, 171 (48%) had a single perforator and 188 (52%) had multiple perforators, with an average number of 2 perforators per DIEP flap. The internal mammary artery (IMA) and vein (IMV) were used as the recipient vessels for 99% (n = 403) of flaps. In the remaining cases the thoracodorsal artery (TDA), thoracodorsal vein (TDV), and cephalic vein (CV) were used. Additional venous drainage was deemed necessary for 11% (n = 48) of flaps. Microsurgical revision was performed in 7% of cases (n = 30). Partial flap failure occurred in 9 flaps and was corrected with debridement combined with a local advancement flap (n = 4), a latissimus dorsi musculocutaneous flap (n = 3), or primary closure (n = 2). Two patients suffered total flap failure, which was revised with early radical debridement, followed by tissue expander placement (n = 1) and superior gluteal artery perforator (SGAP) flap reconstruction (n = 1).

Based on this experience, practical algorithms were developed for flap selection, treating venous congestion, partial and total flap failure.

Research question 3: How many additional operations are required after DIEP flap breast reconstruction to achieve a pleasing end result?

Additional operations to improve the aesthetic result or deal with complications are presented in **chapter 4**. On average, 1.4 additional operations were needed to achieve a satisfactory end result for the patient. Patients with complications underwent 1.9 additional operations compared to 1.2 for patients without complications. There was no relationship, however, between occurrence of complications and the number of additional aesthetic operations or the choice for nipple reconstruction. Procedures that were performed most frequently included nipple reconstruction, shaping of the reconstructed breast, scar revisions, and procedures to improve symmetry by lifting or reducing the contralateral breast.

Patient and plastic surgeon decided together whether or not to proceed with additional operations. In general, the plastic surgeon offered or agreed to perform an operation, if it was technically feasible to improve the result and if the risk was acceptable. We did not assess why patients who were not (fully) satisfied ceased to pursue further improvements.

Research question 4: How satisfied are patients after undergoing DIEP flap BR and what is the impact of this procedure on body image, sexuality and quality of life?

In **chapters 4-6** we showed patients to be very satisfied with the end result of their DIEP flap breast reconstruction with a mean overall score of approximately 8 out of 10, regardless of timing of reconstruction and despite an overall complication rate of approximately 30%. Patients who had experienced complications and patients who had not were equally satisfied, in contrast to previous studies showing postoperative complications to be a particularly important indicator of dissatisfaction.[10,11] On average, patients had undergone 1.4 additional operations to complete their BR process. Patients with and without nipple reconstruction were equally satisfied with the end result.

High satisfaction scores with symmetry, scars on the reconstructed breast, and nipple/nipple areola complex were significantly and positively related to overall patient satisfaction, which is in line with previous reports.[12] In addition, patient satisfaction was particularly positively related to being satisfied when dressed, having no complaints with regard to the BR, and the reconstructed breast feeling like their own. The percentage of women who were *very* satisfied decreased steadily, as clothing became less concealing, confirming that more intimate situations make increasing demands on BR.

In tertiary reconstructions, reduction or disappearance of physical discomfort was noted in the vast majority of patients who had been motivated by pain or tightness.

Our study-specific questionnaire had previously been used to evaluate patient satisfaction after implant BR.[13,14] Unfortunately, the study populations differed too much with regard to timing and laterality, rendering direct comparison of satisfaction rates between both techniques impossible. As mentioned above, a multi-centre prospective follow-up study is currently underway directly and extensively comparing both techniques.

Research question 5: What are the surgical outcome, patient satisfaction, and aesthetic result after tertiary autologous BR?

In **chapter 6** we assessed the technical and psychological outcomes of free flap BR in 42 patients after failed implant BR; both DIEP flaps (n = 47), mini-TRAM flaps (n = 10) as well as TMG flaps (n = 4) were included. Complication rates after tertiary autologous BR were comparable to those after primary and secondary DIEP flap BR, rendering it a technically feasible and reliable procedure. However, extensive previous surgery and complications in the local area potentially make tertiary reconstructions more challenging.

Physical discomfort caused by implants and dissatisfaction with the aesthetic result were the main patient motivations to opt for autologous BR. Reduction or disappearance of physical discomfort was noted in the vast majority of patients. Most patients were very satisfied with the aesthetic result (mean satisfaction score, 8 out of 10) and according to a panel of experts there was a statistically significant improvement of the aesthetic result after conversion into autologous BR (increase in mean satisfaction score from 5 to 7 out of 10).

Research question 6: What are the cost implications of four BR techniques?

In **chapter 7** we comprehensively assessed short- and medium-term intramural medical costs, extramural medical and non-medical costs. Short-term intramural medical costs after DIEP flap BR were highest (unilateral €12,848, bilateral €15,747), but the difference with TE/SP reconstructions (unilateral €12,400; bilateral €12,723) was limited. Bilateral LD transpositions (€10,760) were predominantly performed in two stages and therefore nearly twice as costly as unilateral LD transpositions (€5,804). SP reconstructions were the cheapest (unilateral €4,731; bilateral €6,784).

Medium-term costs for complications and additional operations were not significantly different (€3,017-€4,503) and differences in short-term costs between techniques did not level out during follow-up. Extramural medical costs and non-medical costs were approximately €9,300 per stage, regardless of technique.

In our series, single-stage SP reconstructions were least expensive, in both short- and medium-term. Due to high complication rates, however, this technique is not suitable for all patients and is only recommended in distinct situations. Definite implant placement is increasingly preceded by tissue expansion at more comparable costs to autologous BR. Incorporation of non-medical costs into the cost-analysis would render two-stage procedures more costly than autologous BR.

Research question 7: Which preferences do patients have with regard to different BR modalities and which trade-offs do they make between treatment characteristics?

In **chapter 8** we explored patients' preferences for different BR modalities after (prophylactic) mastectomy using a discrete choice experiment (DCE). Analysis of the trade-offs that respondents made showed that autologous material and an excellent aesthetic result were generally the most important (positive) determinants in women's choices for a specific type of BR. However, short- and long-term complication rates of 20 and 30%, respectively, had a similar negative effect on utility. Interestingly, waiting time hardly affected utility levels.

Based on women's preferences and realistic values for attributes, relative utility scores were calculated for several types of BR and subsequently ranked. Autologous BR (e.g., DIEP flap, extended LD transposition without implants) were awarded the highest utility scores by our study population and therefore seemed to fit in best with patients' preferences.

TECHNICAL ASPECTS

Methodological considerations

Most data regarding technical aspects of autologous BR was gathered from the prospective database on all patients who had sustained DIEP flap BR at the Erasmus MC since 2002. Accurate complication registration remains a challenge. Major complications resulting in re-operations or re-admissions are rather straight-forward. Minor complications, however, such as prolonged wound healing, wound infection, and fat necrosis, are more subjective and investigator dependent, and were therefore likely less accurately scored.[15] In an attempt to promote accurate registration, researchers continuously reminded (other) clinicians of the ongoing studies and made sure necessary forms were readily available.

Interestingly, there was a discrepancy between the complications that had been registered in our database ("objective reality") and the complications that were reported by patients in the questionnaires ("perceived reality"). Thirty-seven percent of registered complications were not experienced as such by patients and included microsurgical revision, partial flap failure, and wound dehiscence. Reported complications that had not been registered in the database (24%) consisted of minor wound healing problems and infections.

Interpretation of results

Complications

In general, the complication rates presented in our studies are comparable to those of others.[3,16] Some specific problems that we encountered and addressed in **chapter 2** and **chapter 3** – mastectomy skin flap necrosis after primary BR, pulmonary embolism – have recently been addressed by others as well.[17-19] Consistent with our experience, Davies et al. found significantly higher rates of wound dehiscence with the Wise and the "tennis racket" incision compared to the periareolar incision. There was no significant difference between diathermy or blade dissection techniques, or the use of subcutaneous adrenaline infiltration. Increasing BMI was associated with increased skin flap necrosis and wound dehiscence, and an excised breast mass of more than 750 g and a sternal notch to nipple length of more than 26 cm were also associated with increased mastectomy skin flap-related complications.[20] Our current strategy is to perform a periareolar incision in combination with a purse string suture for large and ptotic breasts. In case of excess skin inferiorly, we convert to a small tennis racket incision. Further adjustments with a horizontal incision in the IMF are performed in a second stage, as described by Liu et al.[21]

Lemaine et al. analysed deep venous thromboembolism (DVT) and pulmonary embolism (PE) by systematically performing bilateral lower extremity duplex ultrasound in

118 patients. The incidence of postoperative DVT was 3.4%, with all events being clinically silent. There was no incidence of symptomatic pulmonary embolism (PE) or sudden death.[16] Since our adjustments to our protocol as presented in **chapter 2**, we encountered another 3 cases of clinically symptomatic PE. In total, 8 out of 261 patients (3.1%) suffered this complication. We have no data on clinically silent VTE in our series. First analysis suggested a relationship between the occurrence of PE and bilateral DIEP flaps, longer operation times, and obesity (BMI > 30 kg/m2). We are currently assessing our series in greater detail. As mentioned above, obese patients are currently required to loose weight in order to be eligible for DIEP flap BR.

Additional operations

Additional operations after BR have recently also been addressed by Leone et al. and Enajat et al.[22,23] Neither incorporated patient satisfaction, but Leone did compare multiple reconstructive techniques. The number of additional procedures after primary DIEP or SIEA BR as presented by Enajat and co-workers was comparable to our results (1.06 additional operations per patient, including 0.17 additional operations due to complications).[22] Leone and colleagues assessed contralateral procedures after unilateral primary breast reconstruction. Delayed reconstructions more frequently required symmetrization than immediate reconstructions. The percentage of contralateral procedures was higher for implant reconstructions than for autologous reconstructions, and the type of mastectomy was significantly associated with symmetrization procedures. These findings showed that non-skin-sparing mastectomy needed symmetrization surgery more frequently than skin-sparing mastectomy.[23] In our series, no statistically significant differences could be discerned in number or type of additional breast operations between unilateral and bilateral reconstructions or between primary and secondary reconstructions.

Previous studies are conflicting as to whether nipple reconstruction improves patient satisfaction. Some investigators doubt the added benefit,[10,24,25] while others report a significantly higher satisfaction.[12,26] We did not detect a correlation between nipple reconstruction and overall satisfaction, but specific patient satisfaction with nipple/nipple areola complex was associated with overall satisfaction. Buck et al. evaluated the evolution of patient satisfaction throughout two-staged TE/SP reconstructions. Initial differences between unilateral and bilateral cases and between the first and second stage were nearly eliminated after completion of the entire reconstructive process. Completion of all three stages, including nipple-areolar complex reconstruction, resulted in the highest satisfaction scores for both unilateral and bilateral reconstructions.[27]

Our results confirm that the reconstructive process generally consists of multiple stages. It is important for patients to be aware of this and it should therefore be emphasized in the preoperative patient information.

Tertiary breast reconstruction

Tertiary autologous BR after failed implant BR has gained interest recently and perforator flaps are generally considered a good solution for patients who have experienced failed implant-based reconstructions or those requiring irradiation.[7] In our series, 19% of patients underwent autologous BRs to salvage failed implant-based reconstructions; Hamdi et al.

reported 8% and Levine et al. 15%.[28,29] Another study reported 10% of irradiated patients to go on to have autologous BR after failed TE/SP reconstructions.[30]

Physical discomfort caused by implants and dissatisfaction with the aesthetic result were the main patient motivations to opt for autologous BR, which is comparable to those reported by Levine et al.[29] Interestingly, however, the majority of patients who opted for tertiary autologous BR because of the unnatural appearance and feel of the implants, only had Baker grade I or Baker II capsular contracture and had not undergone radiation. Implant failures are traditionally thought to be in patients with Baker grade III/IV capsular contractures and in patients after radiation therapy.[29]

Tertiary autologous BR can generally reduce physical discomfort and improve the aesthetic result. Satisfaction scores were very similar to those reported previously by women who had undergone primary or secondary BR, but patients who underwent tertiary BR suffered more complications and experienced more donor-site discomfort and dissatisfaction than patients with primary or secondary reconstructions. Preoperatively, patients should be informed accordingly.

PSYCHOLOGICAL ASPECTS

Methodological considerations

Internal validity

Preoperative or baseline data and a control group were not incorporated in our cross-sectional, observational questionnaire studies, making it difficult to draw definite conclusions on the causal relationship between the high satisfaction scores and DIEP flap BR. Our studies, however, were pilot studies for a prospective, multicentre study comparing DIEP flap BR to implant reconstructions (DIM study), which is currently being performed. In this longitudinal study baseline data are taken into account.

From a psychological perspective, cognitive dissonance may have played a role in patients' attitude towards their selected BR type. Cognitive dissonance is the psychological discomfort caused by inconsistency among a person's beliefs, attitudes, and/or actions, which induces a "drive state" – a need to avoid or reduce dissonance by changing beliefs, attitudes or behaviours so they are perceived as consistent.[31] Patients who previously underwent BR are likely to incorporate their experiences in their answers and may defend or justify their choice and treatment, thus affecting their response to our questionnaires.

External validity

Psychological aspects were studied in a population of patients who underwent DIEP flap BR at the Erasmus MC since 2002. As our university hospital is specialized in prophylactic mastectomies in genetically predisposed patients, the numbers of primary BRs in our study sample were high compared to normal practices. This potentially creates a selection bias, as the point of reference of genetically predisposed patients differs from that of breast cancer patients. A patient with a history of BC generally undergoes a unilateral secondary reconstruction, while a genetically predisposed woman is more likely to undergo a bilateral prophylactic mastectomy and primary BR. Women with primary reconstructions

will compare their reconstructed breast(s) to their natural breast(s) and might therefore be more critical. The experience of a mutilated body due to a previous mastectomy might result in women with secondary reconstructions being more easily pleased. Similarly, the psychological impact of a therapeutic mastectomy for breast cancer differs from that of a prophylactic mastectomy.

We wanted to assess several psychological aspects of DIEP flap BR, such as patient satisfaction, and effects on health-related quality of life (HRQoL), body image, and sexuality. At the start of this research project there were no appropriate instruments available which were specifically directed at measuring psychological aspects of BR. According to a recent review, even the best patient-reported outcome measures do not address all important surgery-specific and psychometric issues of oncologic breast surgery patients.[32] Another review showed current methods for assessing cosmetic outcome after BR to vary widely and suggested that outcome reporting is inconsistent and lacks methodological rigor. A valid patient-centred assessment method is required to fully understand the outcomes of BR and to inform decision-making.[33,34] Recently, the BREAST-Q has been constructed, which is a validated patient-reported outcome measure, specifically aimed at providing essential information about the impact and effectiveness of breast surgery from the patient's perspective.[35]

We used study-specific questionnaires to evaluate different aspects of patient satisfaction. In addition, we used the Short Form-36 (SF-36) to assess general health-related quality of life.

The study-specific questionnaires were modified from a questionnaire previously constructed at our institution.[13,14] It evaluates patient satisfaction, feeling informed about the surgical procedure and its possible consequences, peri- and postoperative complications, physical complaints, and limitations attributable to BR, and effects on body image, social functioning, sexuality and femininity. The questionnaire used for evaluating tertiary breast reconstructions was adjusted to address some of specific issues concerning tertiary breast reconstruction. Our results provide a good impression of psychological outcome and patient satisfaction after DIEP flap BR. As these study-specific questionnaires were not validated, however, direct comparison with other studies is difficult.

SF-36 is a validated and reliable tool to asses (changes in) general HRQoL. However, generic instruments such as SF-36 may not be sufficiently sensitive to measure changes consequent to BR as they are not designed to detect changes in such specific aspects of health.[36-38]

Interpretation of results

Patient satisfaction

Reconstructive breast surgery is primarily aimed at satisfying the patient with the reconstructed breast. Patient satisfaction is very personal – one patient might be very satisfied with a technically suboptimal result, while another patient is dissatisfied with a technically outstanding result – and highly depends on patients' expectations and points of reference. Patients' points of reference are largely determined by timing and laterality of BR, which in turn also affects the technical ability to reconstruct a natural and symmetrical breast. Primary reconstruction, especially in combination with skin-sparing mastectomy,

often allows preservation of important aesthetic landmarks such as infra-mammary fold (IMF) and skin envelope. Patients' expectations will partly determine whether patients are satisfied with their reconstructed breast and will (further) pursue additional operations.

Several studies have evaluated the impact of different reconstructive techniques. Autologous BR is generally considered to provide a superior aesthetic result, but some results are conflicting.[39-41] According to Yueh et al., autologous reconstruction – especially abdominal-based flaps – resulted in significantly higher general and aesthetic satisfaction rates than implant-based reconstruction.[42] Tonseth et al. used a study-specific questionnaire to compare DIEP flap BR with BRs using expandable breast implants and showed DIEP flap patients to be more satisfied.[37] In contrast, Spear et al. showed higher satisfaction levels after TE/SP reconstructions, followed by TRAM flaps and LD transposition, but satisfaction rates were high across all three groups.[43] We present high satisfaction scores after DIEP flap BR. Our study design does not allow direct comparison with other techniques, but this is currently being addressed in a prospective, multicentre study.

Preoperative patient information

Preoperative education is aimed at helping patients to make a deliberate and conscious decision about breast reconstruction. By creating realistic expectations, patient satisfaction may be increased in women who choose for or against (a specific type of) BR. Significant variability exists among patients and between patients and providers with respect to the most important facts about and goals of breast reconstruction.[44] Understanding patients' expectations allows surgeons to identify those patients, who hold inaccurate expectations preoperatively, and to reset those expectations through focused preoperative education and subsequently improve patient satisfaction with surgical outcomes.[45] Fernandes-Taylor et al. showed over 40% of women to regret some aspect of their BC treatment, including nearly 20% regretting decisions about BR. Communication with physicians proved very important in this matter.[46]

Several aspects can influence the provision of and need for information, such as the indication for mastectomy, timing of reconstruction, and type of reconstruction. In general one would expect patients undergoing secondary reconstructions (or primary BR after "elective" prophylactic mastectomy) to have more time and opportunity to gather information. In addition, DIEP flap BRs are more demanding for patients than implant reconstructions, and one would expect a more thorough evaluation of pros and cons before deciding in favour of this procedure. Indeed, women who choose autologous BR tend to be higher educated and independent decision-makers in their health care choices. They use the internet to learn about breast reconstruction techniques and are more likely to self-refer to a reconstructive surgeon.[47,48]

In our setting, extensive preoperative information was given orally and in writing at the outpatient clinic and patients were enabled to contact patients who had already undergone the same procedure (live patient-to-patient meetings). Previous studies in women undergoing primary reconstructions using implants showed dissatisfaction to be related to lack of preoperative information. No such correlation was found in our series, as about 90% of patients reported to be sufficiently informed about the procedure and its consequences. Patients undergoing tertiary BR indicated that the preoperative information on "limitations after surgery" was inadequate and needed improvement. Preoperative

consultations were consequently adjusted accordingly. A recent review highlights the need for well-designed, methodologically sound research into patient education regarding breast reconstruction.[49]

Accurate preoperative education is essential for a successful informed and shared decision-making process and its importance can not be stressed enough.[50] We hope that the results presented in this thesis contribute to this.

ECONOMIC ASPECTS

Methodological considerations

Costs

The basic tasks of any (health) economic evaluation are to identify, measure, value, and compare the costs and benefits of alternatives being considered. From a societal perspective, the relationship between costs and benefits should be reasonable in order to warrant the expenditure. Clinical outcome measures such as complication or failure rates often do not suffice to measure the effectiveness of an intervention, as patient satisfaction and the impact on HRQoL have to be taken into account as well.[51-54]

Traditional means of measuring health care benefits have concentrated on improvements in health outcomes using Quality Adjusted Life Years (QALY). The QALY is a measure of the quantity of life gained weighed by the quality of that life. [55] Several authors have previously attempted to use QALYs as an outcome measure in cost-utility analyses comparing different BR techniques.[56-58]

QALYs, however, primarily capture health outcome benefits,[59-61] while total benefits of an intervention can also be derived from non-health outcomes (e.g., patient satisfaction, aesthetic result) and process characteristics (e.g., number of operations, waiting list). Especially for interventions that do not provide reduction in morbidity or mortality (such as breast reconstruction), these aspects might be relevant for individuals' preferences and acceptability for specific techniques.

We decided to perform a detailed cost-analysis, comprehensively assessing the financial implications of four major BR techniques from a societal perspective, based on actual resource use. Clinical outcome measures such as complications and success and failure rates were described in detail as a measure for technical success. In addition, we designed a discrete choice experiment to evaluate the effects of health, non-health, and process aspects on patients' preferences. Unfortunately, it is not (yet) possible to incorporate data from a DCE directly into a cost-utility analysis.

Discrete choice experiment

Internal and external validity. Patients' preferences were studied in a population of patients who had undergone either a mastectomy and/or a BR at the Erasmus MC between 2002 and 2009. As our university hospital is specialized in prophylactic mastectomies in genetically predisposed patients and free flap BR, the numbers of primary and DIEP flap BRs in our study sample were high compared to normal practices. As mentioned above, this potentially creates a selection bias. The relatively difficult task of a DCE questionnaire, in

which patients repetitively have to make a choice between multiple hypothetical scenarios, might also induce a selection bias. This would be to the benefit of DIEP flap patients, as they are generally higher educated.[48] Our overall response rate was 71%. Ninety-nine percent of respondents passed the dominant question, demonstrating their understanding of the DCE task. We do not know whether non-respondents were comparable to respondents with regard to level of education.

As all respondents had experienced mastectomy and a majority of patients had also undergone BR, they were able to identify themselves with the choices presented in the questionnaire, which is one of the prerequisites for a successful DCE. This design is less suitable to predict actual choice behaviour, the strongest form of evidence for (external) validity of a DCE, as in real life decisions had already been made. In contrast, a prospective design, using women who are about to undergo or have already undergone mastectomy and are currently deciding on BR, is less practical to assess patients' considerations and trade-offs, but does allow external validation of results by comparing stated preferences to actual behaviour.[62] Our results were in line with each other, demonstrating our study's (internal) validity.

Interpretation of results

Costs

Intramural medical costs. Previous studies showed that BRs using implants initially were less expensive than autologous BRs,[63] but that costs levelled out within 5 years due to complications and re-operations.[64] In our study, differences in short-term costs did not level out during follow-up and SP reconstructions remained the least expensive.[65] These results are comparable to those recently published by Atherton et al.[66] Even though the number of complicated and salvaged reconstructions was significantly higher after implant BR, the number of failed reconstructions was comparable to other types of BR. Correcting costs for the ultimate success rate therefore did not change results drastically.

Our study's mean follow-up of more than 5 years can be considered medium-term. As long-term complications and subsequent costs can still occur after more than 20 years, longer follow-up is still required. If followed up long enough, implant-based reconstructions are expected to lose the financial benefit.

Technical limitations of one-stage SP reconstructions have been described elsewhere. The results of this reconstructive technique have previously been analysed at our institution, showing high complication rates (approximately 40%) and relatively low satisfaction scores (60 – 70%).[13,14] Careful patient selection is critical and inappropriate use of this technique would further increase complication rates with obvious effects on patient satisfaction, demand for tertiary BR, and costs.

The results from our DCE indicate that patients generally prefer autologous tissue, an excellent aesthetic result, and low complication rates. In general, SP reconstructions are not the most suitable to meet these requirements and these preferences cannot be dismissed purely based on our analysis of short- en medium-term costs. It could be argued that the (initial) financial difference is justified by the increased patient satisfaction and aesthetic outcome.[66]

Extramural medical and non-medical costs. From a societal (or tax payers) point of view intramural medical, extramural medical and non-medical costs are all equally important. To our knowledge, extramural medical and non-medical costs have not been incorporated in a cost-analysis regarding BR before. We showed that non-medical costs particularly contributed substantially to total costs for society.

Breast cancer predominantly affects middle aged women. In our study, the average age of women undergoing BR was 45 years and 65% of them had a job at the time of surgery. Productivity costs accounted for approximately 98% of extramural medical and non-medical costs. Surprisingly, patients returned to work approximately 10 weeks after surgery, regardless of type (or stage) of BR. Productivity costs came to more than €9000 per operation, which is on the same scale as short-term intramural medical costs for the actual BR. Consequently, two-stage procedures (e.g., TE/SP reconstructions, bilateral LD transpositions or S-GAP flaps) become more expensive from a societal perspective than single-stage procedures and incorporation of these costs into the cost-analysis would seriously alter the results.

Financial reimbursement. In 2005, a new casemix system for hospitals was introduced in the Netherlands. This so-called DBC-system (Diagnose-Behandel-Combinatie; Diagnosis-Treatment-Combination) was introduced into Dutch healthcare in order to gain more insight in prices, content, and quality of delivered care, both nationwide and within hospitals. A DBC can be defined as a predefined average packet of care (treatment) with – in most cases – a fixed price, which is applied when a specific diagnosis occurs. The DBC-system is used for registering as well as paying for delivered care.[67]

At the beginning of this research project, the set price for autologous free flap BR was set at €8205, compared to €2828 for SP, €6716 for TE/SP, and €6390 for LD ± SP reconstructions.[68] The changes in prices in recent years are shown in the table, underlining the lack of a persistent relation between hospital charges and actual costs and the reason why we based our cost calculations on observed resource use and actual unit prices. The costs presented in **chapter 8** apply to the financial year 2006.

The DBC system does not always differentiate between unilateral and bilateral reconstructions. Reimbursement for unilateral and bilateral SP reconstructions is the same. In contrast, fixed prices for TE/SP reconstructions were separated in 2008. Interestingly, unilateral reconstructions are awarded more money than bilateral reconstructions. For bilateral LD reconstructions, we have to differentiate between those performed in one stage and those performed in two-stages. For those performed in two stages you can charge the fixed price for a unilateral reconstruction twice. Bilateral LD transpositions performed in one stage were originally not additionally compensated and only received the fixed price for a unilateral reconstruction. Only since 2007, bilateral autologous BR, both LD transpositions and DIEP flaps, have been awarded an additional charge.

When comparing actual costs to the fixed prices of December 2010, unilateral reconstructions seem to be remunerated quite fairly, with the exception of TE/SP reconstructions. It is worth to mention that the estimated costs for unilateral TE/SP reconstructions might be an overestimation of actual costs due to relatively high complication rates in our series. In bilateral cases, fixed prices for autologous reconstructions are quite accurate, while those for implant based reconstructions are too low.

The financial reimbursement for breast reconstruction is also a point of discussion in other countries. Authors from England, Germany, and the USA have highlighted areas of financial inequality and imbalances between allocated tariffs and actual resource use for certain procedures. Remuneration for bilateral procedures, multiple simultaneous procedures, and use of implants is frequently insufficient and varies dramatically by type and timing of reconstructive procedure.[66,69-71] At our institution, for example, implant material is currently not covered by the fixed price and has to come out of the department's own budget.

Insight in the relation between costs and remuneration is of interest to medical consultants, hospital boards, and insurance companies. With increasing financial pressures there may be an unwanted drive towards simpler, cheaper, and more profitable operations. In contrast, a poor financial return on labour-intensive procedures, despite superior aesthetic results and patient satisfaction, would negatively affect its availability. Our analysis of costs and charges, however, suggests that LD transpositions and DIEP flaps are currently more profitable (or less unprofitable) for health care providers than implant based BR.

Table 1 | Fixed prices for unilateral and bilateral reconstructions,[68] in relation to actual costs as presented in this thesis.[65] All costs are presented in Euros.

Unilateral	December 2005	December 2006	December 2007	December 2008	December 2009	December 2010	Actual costs
SP	2762	2828	2944	4643	4802	4243	4731
TE/SP	6566	6716	6144	9387	9700	8992	12400
LD ± SP	6242	6390	5877	8740	9037	7579	5804
DIEP	8012	8205	8863	13613	14085	11270	12848

Bilateral	December 2005	December 2006	December 2007	December 2008	December 2009	December 2010	Actual costs
SP	2762	2828	2944	4643	4802	4243	6784
TE/SP	6566	6716	6144	8908	9202	8490	12723
LD ± SP	6242	6390	8130*	14057*	14559*	12022*	10760**
DIEP	8012	8205	12821	20524	21243	16925	15747

* These prices are appropriate when a bilateral LD transposition is performed in one stage. If a bilateral reconstruction is performed in two separate stages, the fixed price of a unilateral LD transposition can be charged twice.

** Most bilateral LD transpositions in our series were performed in two separate stages, in which case the fixed price of a unilateral LD transposition can be charged twice.

Changes in clinical practice and future developments

Breast reconstructive practice is constantly subject to change. Current practice and subsequently its costs have already evolved from the situation presented in **chapter 8**. Currently, patients are more liberally discharged with drains, which is especially favourable in decreasing the costs of autologous BRs. Also, LD transpositions are increasingly combined with tissue expansion, which was not incorporated in this study, but will predictably result in higher costs of LD transpositions. Based on the rather high complication rate after TE/SP reconstructions in our series, perioperative protocols have been successfully changed to minimize infections and reduce the early explantation rate. Furthermore, several technical developments are currently being investigated and might be implemented in the near future. Some of these developments will be briefly discussed.

Preoperative imaging. The vascular anatomy of the deep inferior epigastric artery and its perforating branches in the abdominal wall varies greatly not only among individuals but also from one side of the abdomen to the other. Perforator location, number, calibre, and the intramuscular trajectory of the branches all impact the design and harvest of the flap. Knowledge of this anatomy facilitates surgical planning and could decrease operating room time, donor site morbidity, intraoperative complications, and length of stay.[72]

Traditionally, hand-held Doppler and color Doppler (duplex) ultrasound were most widely used, but recently more advanced imaging modalities such as CT angiography (CTA) and MR angiography (MRA) have been advocated for preoperative planning. Recent studies showed that both duplex ultrasound and CTA can be used preoperatively for accurate DIEP mapping, but most demonstrated the superiority of CTA over duplex ultrasound.[73-76] Preoperative CTA has been shown to result in shorter operating times and reduced complications.[77] Alternatively, perforators can be visualized without exposing patients to ionizing radiation or iodinated intravenous contrast through MRA. MRA certainly has a role in the imaging of DIEA perforators, but CTA remains more accurate.[78-80] Consequently, CTA has become the gold standard for preoperative DIEP flap planning in many practices, including the Erasmus MC.[81] Others only prefer CTA over duplex ultrasound in selected cases because of x-ray exposure or even refrain from any preoperative mapping and trust intraoperative perforator dissection.[73]

Acellular dermal matrices. Complete submuscular placement of an implant offers the best protection against implant exposure but restricts lower pole expansion. Techniques using acellular dermal matrices (Alloderm, Strattice) as a pectoralis muscle extension facilitate immediate TE/SP breast reconstruction by providing support and coverage to the inferolateral pole, improving control of implant position and IMF, and enhancing early volume expansion. By allowing bigger intraoperative tissue expander fill volumes, mastectomy skin flaps are better preserved, which potentially improves cosmetic outcome. Also, less additional expansions are required prior to tissue expander-to-implant exchange.[82,83] This technique facilitates primary single-staged SP reconstructions as well and could replace the need for additional soft tissue supplied by LD transpositions.

Despite its benefits, however, the use of dermal substitutes is generally associated with increased complication rates.[84-91] The use of dermal substitutes therefore requires judicious patient selection; age, smoking, body mass index, breast size, axillary dissection,

and postoperative chemotherapy have been associated with reconstructive failure and developing complications.[84,86,87] Based on clinical observations, a decreased capsular contracture rate is suggested for breast implants covered with acellular dermal matrix, as confirmed in an animal model and by histopathologic analysis,[92,93] but the true incidence will remain unknown until longer follow-up data become available.

In the Netherlands, this technique is currently only applied at a small scale within a clinical trial. One of the issues that needs to be dealt with before this technique can be embraced, is the financial reimbursement. The use of acellular dermal matrix costs approximately €2000 per reconstructed breast. If the added benefits of this technique have been sufficiently documented, its widespread introduction will largely depend on the insurance companies' willingness to reimburse these additional costs.

Lipofilling. Autologous fat grafting and lipofilling are also increasingly propagated for the repair of defects after breast cancer treatment.[94] Some authors advocate a combination of lipofilling with nonsurgical pre-expansion of the breast.[95,96] Breast enlargement using an external soft-tissue expansion system (Brava system) is based on the ability of tissues to grow when subjected to controlled distractive mechanical forces and was introduced by Khouri et al.[97]

Lipofilling could potentially reduce the indication for the use of implant material and more extensive autologous techniques. Postoperative complication rates are low and there is little alteration in follow-up mammograms.[98] The amount of fat that is absorbed varies and could be as much as 40-50%.[94,99] As a result this technique normally requires several stages.

Injection of fat into the breast is not a new idea, but it has always been controversial. It could lead to the formation of calcifications and cysts that might hinder mammagraphic examinations for detection of possible breast cancer. Also, intentional placement of regenerating tissue at the site of tumor resection raises questions concerning the possibility of promoting locoregional BC recurrence.[100] Most authors, however, state that lipofilling is efficient and safe, while others suggest that it should be deferred until cancer remission has been firmly established.[101,102]

Discrete choice experiment

Discrete choice experiments provide valuable insight into the relative importance of attributes, the rate at which individuals are willing to trade between attributes, and the relative utility scores for intervention alternatives. The preferences of a group cannot be used to predict real choices or behaviour for an individual patient. This information can be useful to guide patient education and support the medical-decision process about the most appropriate reconstructive technique for an individual patient. At group level, our data can support policy makers to attune supply and demand and health care providers to improve the quality of their care.

We performed the first DCE on BR, introducing a relatively new methodology to evaluate respondents' preferences. This concept can be applied to many clinical questions regarding patient preferences on plastic surgery topics, especially when relative utility scores can be used as outcome measure in a cost(-utility) analysis. It is currently not possible

to transform relative utilities into absolute utilities or calculate QALYs, but research on this topic is ongoing.[103,104]

Based on our data, autologous BR (e.g., DIEP flap, extended LD transposition without implants) seemed to fit in best with patients' preferences, as our study population awarded these techniques the highest utility scores. In an attempt to match BR techniques to consumers' demands and to further increase utility for the patient, we should focus on further reducing short- and long-term complication rates and improving the aesthetic result. In contrast, reducing the waiting time would hardly benefit the patient.

Professional assessment of technical feasibility, acceptable risks, and obtainable aesthetic result will always remain crucial to decide which technique is best suited for an individual patient. Adjuvant radiation therapy, for example, is a contra-indication for implant BR, while sufficient excess abdominal tissue is a prerequisite for autologous abdominal based BR. Extended LD transpositions without implants cannot achieve the same volume as DIEP flap BR. Also, surgeon's personal preference has been shown to play an important role.[105] Our results, however, implicate that all patients are at least entitled to detailed information about autologous BR, even if that technique is not available in that particular institute or is not offered by that particular plastic surgeon.

OVERALL CONCLUSIONS

Multiple BR techniques are available, differing in characteristics such as material used, duration of the operation(s), recovery period, complication rates, aesthetic result, and costs. To determine the most suitable option for an individual patient, multiple factors have to be considered to assess which methods are technically feasible and which risks acceptable. Careful patient selection is critical to limit complications and achieve the optimal result. In this light, accurate patient information resulting in realistic expectations is also of vital importance.

We conducted studies on various aspects of (autologous) breast reconstructions, hoping to improve our ability to quantify the optimal breast reconstruction technique for individual patients. We showed DIEP flap BR to be a safe and reliable procedure in primary, secondary, as well as tertiary cases, yielding good results with high patient satisfaction after approximately 1.4 additional operations. Donor-site morbidity was generally limited. Compared to other procedures, short-term medical costs were highest after DIEP flap BR, but differences with TE/SP and bilateral LD transpositions were limited. Even though differences did not level out during our follow-up, DIEP flap BR demonstrated its economic viability. Cost comparison does not seem a valid argument for treatment selection. Patients revealed a strong preference for autologous material and an excellent aesthetic result, as these attributes had the biggest positive effect on utility. However, short- and long-term complication rates potentially have a similar-sized negative effect on utility.

RECOMMENDATIONS

For further research

Overall, our results have met the aims of this thesis as put forward in **chapter 1**. Strengths and weaknesses of the individual studies have been addressed in the discussion. Some questions were (deliberately) left unanswered and some new questions arose, leaving plenty of room for future studies on this topic. The studies presented in the first part of this thesis did not compare DIEP flap BR to other types of BR. As mentioned, some of these studies served as pilot studies for a prospective multicentre follow-up questionnaire study on the psychological effects of different types of BR. This study will also address patients' personality and expectations in more detail, while taking baseline data into account. Similar to our analysis in **chapter 6**, subjective patient satisfaction will be related to more objective outcome measures as determined by a panel of experts.

Both the cost-analysis and the discrete choice experiment introduced new concepts to the field of plastic and reconstructive surgery. To our knowledge, we are the first to perform a cost-analysis on BR from a societal point of view. Incorporating extramural medical and non-medical costs could have a major impact and might be appropriate to other treatments involving hand- or reconstructive surgery. With regard to the cost-analysis, the same patient population can be reassessed in 5 – 10 years' time, allowing long(er)-term costs to be assessed. In addition, costs and benefits of new developments such as acellular dermal matrices, lipofilling, and preoperative imaging have to be weighed and assessed for cost-effectiveness.

For clinical practice

Breast reconstruction should be an integral part of the treatment of breast cancer. We should therefore continue to invest in educating referring surgeons and patients about reconstructive indications and options in order to positively affect the utilization of breast reconstruction. Thankfully, attitudes towards breast reconstruction continue to change among both patients and providers, as is also reflected by the introduction of the concept of oncoplastic surgery, which results in an increased demand for primary and partial BR.[106]

The DIEP flap procedure is momentarily not offered to all women opting for breast reconstruction. Given the fact that DIEP flap BR yields good results, additional costs are limited, and patients seem to have a general preference for autologous tissue, autologous BR should be offered to all mastectomy patients opting for BR. Not every reconstructive surgeon is able to offer all available techniques, but nevertheless they should be able to objectively inform patients about all possibilities, and, if necessary, refer patients to a colleague who does offer this type of BR.

Primary reconstructions have already been shown to be beneficial from a psychological, technical, and financial point of view, without negatively affecting disease free survival.[107,108] Obviously, when productivity costs are also taken into account, financial benefits become even more obvious. With changing attitudes towards (primary) breast reconstruction and advanced possibilities to identify genetically predisposed women, demand for primary reconstructions is likely to increase. In order to facilitate primary

BR, cooperation between referring specialists and plastic surgeons, and the logistics and reimbursement required for primary (autologous) BR should be improved.

For health care policy

The intention to offer (autologous) BR to all patients for whom it is appropriate requires an increase in the availability of breast reconstructive surgeons. Mastectomies are routinely performed in most hospitals and this should also be the case for BR. To achieve this, the number of qualified and specifically trained reconstructive (micro)surgeons should increase. Currently, in the Netherlands there are 1.5 plastic surgeons per 100,000 inhabitants (288 plastic surgeons) with 50% of Dutch hospitals offering no or insufficient plastic surgical care. It has been calculated that in order to correct this shortage, the number has to increase to 2.4 per 100,000 inhabitants (109 additional plastic surgeons).[109] These decisions have to be made at a political level.

In addition, the financial reimbursement system has to guarantee equal access to high quality care. There should be a financial incentive to perform different types of breast reconstruction and to organise care efficiently. Also, quality and continuity of care do not benefit from unexpected and unmotivated changes in fixed prices. Currently, primary BR – which is beneficial for both the patient and society – suffers from unresolved financial, practical, and logistical issues between the general surgeon and the reconstructive surgeon. These issues need to be dealt with in clinical practice as well as in health care policy. Health care is increasingly becoming patient-centred and demand-led and this is likely to result in an increased demand for (primary) BR.

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English summary

Breast reconstruction (BR) is aimed at restoring the amputated breast and thus improving patients' quality of life and body image after mastectomy. There are essentially three types of breast reconstruction, using either implant material, autologous tissue, or a combination of both. Techniques differ with regard to material used, duration of the operation(s), recovery period, complication rates, aesthetic result, and costs. Each technique has pros and cons and therefore its own place in current practice. Breast reconstruction can be performed directly after mastectomy (direct or primary BR) or at a later stage (delayed or secondary BR).

In 2002, the deep inferior epigastric perforator (DIEP) flap was introduced in the Erasmus University Medical Centre (Erasmus MC) in Rotterdam, the Netherlands, and quickly became the preferred method to supply autologous tissue for breast reconstruction. The studies presented in this thesis were performed to give a global overview of technical, psychological, and economic aspects of DIEP flap BR.

TECHNICAL ASPECTS

In **chapter 2** the clinical outcomes of our first 175 consecutive DIEP flap BRs are presented. In 159 cases (91%) a DIEP flap could be raised. A mini-TRAM flap was harvested in 13 cases (7%) and a regular free TRAM flap in 3 cases (2%). Critical assessment of intra- and postoperative problems showed a significant decrease in DIEP flap complications after the first 30 flaps performed in 23 patients. The complication rate dropped from approximately 40% to less than 15%, representing our learning curve. Overall, the microsurgical revision rate was 4%, with a total flap failure rate of 1%. Partial flap failure rate was 9%, which was solved by debridement, medial advancement, and direct closure in 7% and latissimus dorsi flap transposition in 2%. We performed a multivariate analysis of the relationships between the occurrence of flap and donor-site complications and multiple risk factors and patient characteristics. No significant relationship was found between DIEP flap complications and smoking, diabetes, hypertension, excessive BMI (> 30 kg/m^2), pregnancy, previous radiotherapy or abdominal operations. There was a trend, however, indicating that smoking and diabetes had a negative effect on DIEP flap complications. Abdominal complications were only significantly related to diabetes and hypertension.

In **chapter 3** we reviewed a single surgeon's experience with 406 free abdominal flap breast reconstructions and specifically focussed on perioperative and intraoperative decisions with regard to flap choice, donor and recipient vessel selection, and early recognition and management of complications. Outcome of microsurgical breast reconstruction largely depends on these decisions. DIEP flaps comprised 88% (n = 359) of all flaps, muscle-sparing TRAM flaps 11% (n = 44), and fascial-sparing TRAM flaps 1% (n = 3). One-hundred-seventy-one (48%) DIEP flaps used a single perforator and 188 (52%) had multiple perforators; the average number of perforators per DIEP flap was 2. The internal mammary artery and vein were predominantly used as recipient vessels (99%; n = 403). Additional venous drainage was required for 11% (n = 48) of flaps. Partial flap failure occurred in 9 flaps, while total flap failure occurred in 2 flaps. Based on this experience, practical algorithms were developed for flap selection, treating venous congestion, and

treating partial and total flap failure, in order to facilitate decision-making and increase the success rate of microsurgical breast reconstruction.

Breast reconstruction is generally performed in multiple stages. **Chapter 4** describes the additional operations following initial DIEP flap BR, either to improve the aesthetic result or to deal with complications. Seventy-two patients who had completed their breast reconstruction were identified in our database. On average, 1.4 additional operations were needed to achieve a satisfactory end result for the patient. Patients with complications underwent 1.9 additional operations compared to 1.2 for patients without complications. There was no relationship between occurrence of complications and the number of additional aesthetic operations or the choice for nipple reconstruction. Procedures that were performed most frequently included nipple reconstruction, shaping of the reconstructed breast, scar revisions, and symmetrization of the contralateral breast.

Most breast reconstructions are performed using implant material. In the long-term, implant-based reconstructions are frequently affected by capsular contracture, which may require implant replacement or removal, or may result in chronic pain and tightness. An increased number of women request conversion of their (failed) implant BR into autologous BR. BR in patients who previously underwent another form of BR is defined as tertiary BR. In **chapter 6** we assessed technical and psychological outcomes of free flap BR in 42 patients after failed implant BR; both DIEP flaps (n = 47), mini-TRAM flaps (n = 10) as well as TMG flaps (n = 4) were included. Complication rates after tertiary autologous BR were comparable to those after primary and secondary DIEP flap BR, rendering it a technically feasible and reliable procedure. However, extensive previous surgery and complications in the local area potentially make tertiary reconstructions more challenging.

PSYCHOLOGICAL ASPECTS

To assess the quality and effectiveness of BR, clinical outcome measures such as complication rates do not suffice. In addition, patient satisfaction and the impact of the procedure on health-related quality of life (HRQoL) should be evaluated in relation to patient's expectations. These and other psychological aspects, such as body image and sexuality, were assessed in **chapters 4-6**.

In **chapter 4**, the number of additional operations was related to patient satisfaction, which was assessed using a study-specific questionnaire. Patients were very satisfied with the end result of their DIEP flap breast reconstruction with a mean overall score of 8 out of 10. Satisfaction with symmetry, scars on the reconstructed breast, and nipple/nipple areola complex were most important aspects of the reconstruction positively affecting overall patient satisfaction. Patients with and without nipple reconstruction were equally satisfied with the end result, as were patients who had experienced complications and patients who had not.

In **chapter 5** we explored patient satisfaction and its determinants as well as the impact of the procedure on body image, sexuality, and HRQoL in more detail. Patient satisfaction and HRQoL were studied in 72 women who underwent DIEP flap BR using a study-specific questionnaire as well as the Short Form-36 (SF-36). Again, patients were very satisfied with the end result of their DIEP flap breast reconstruction with a mean

overall score of approximately 8 out of 10. Approximately 90% of patients reported that they had been sufficiently informed about the procedure and its consequences, that their preoperative expectations had been met, that the reconstructed breast felt like their own, and that they would choose the same procedure again and would recommend it to a friend. Patient satisfaction was positively and significantly related to being satisfied when dressed, having no ongoing complaints with regard to the BR, and the reconstructed breast feeling like their own. The percentage of women who were *very* satisfied decreased steadily, as clothing became less concealing, confirming that more intimate situations make increasing demands on BR. Women with secondary reconstructions were more positive about changes in sexuality and femininity than women with primary BRs. There were no clinically relevant differences in HRQoL between our study population and a random sample of Dutch women.

In tertiary reconstructions (**chapter 6**), physical discomfort caused by implants and dissatisfaction with the aesthetic result were the main patient motivations to opt for autologous BR. Reduction or disappearance of physical discomfort was noted in the vast majority of patients. Most patients were very satisfied with the aesthetic result (mean satisfaction score, 8 out of 10) and according to a panel of experts there was a significant improvement of the aesthetic result after conversion into autologous BR (increase in mean satisfaction score from 5 to 7 out of 10).

ECONOMIC ASPECTS

In **chapter 7** we comprehensively assessed short- and medium-term intramural medical costs, extramural medical and non-medical costs of four BR techniques (silicone prosthesis (SP), silicone prosthesis preceded by tissue expansion (TE/SP), latissimus dorsi transposition with or without silicone prosthesis (LD ± SP), and DIEP flaps). A prospective historic cohort study was performed to evaluate intramural medical costs in 427 patients who had undergone BR between 2002 and 2009. Additionally, 58 patients who had recently undergone BR participated in a questionnaire study to prospectively evaluate extramural medical and non-medical costs.

Short-term intramural medical costs after DIEP flap BR were highest (unilateral €12,848, bilateral €15,747), but the difference with TE/SP reconstructions (€12,400; €12,723) was limited. Bilateral LD transpositions (€10,760) were predominantly performed in two stages and therefore nearly twice as costly as unilateral LD transpositions (€5,804). SP reconstructions were the cheapest (€4,731; €6,784). Medium-term costs for complications and additional operations were not significantly different (€3,017-€4,503) and differences in short-term costs between techniques did not level out during follow-up of more than 5 years. Extramural medical costs and non-medical costs were approximately €9,300 per stage, regardless of technique.

In our series, single-stage SP reconstructions were least expensive, in both short- and medium-term. Due to high complication rates, however, this technique is not suitable for all patients and is only recommended in distinct situations. Definite implant placement is increasingly preceded by tissue expansion at more comparable costs to autologous

BR. Incorporation of non-medical costs into the cost-analysis would render two-stage procedures more costly than autologous BR.

In **chapter 8** we explored determinants of patients' preferences for different BR modalities using a discrete choice experiment (DCE). A DCE allows analysis of the relative importance of treatment characteristics and the trade-offs patients make between them, which provides useful insight into consumers' demands regarding BR. Patients' preferences are important determinants in the decision for a specific type of BR. Understanding women's motivational factors can contribute to further improve patient information and to develop patient-centred and demand-led healthcare.

For this study, 386 patients who previously underwent a therapeutic or prophylactic mastectomy, with or without subsequent BR, were approached. Respondents were repetitively offered a choice between different treatment options and asked to choose the option that appealed most to them. BRs were characterized by six treatment attributes: 1) material used for reconstruction; 2) number and duration of operations; 3) short- and 4) long-term complication rate; 5) aesthetic result; 6) waiting time.

All these treatment attributes proved important for women's choices. Analysis of the trade-offs that respondents made, showed that autologous material and an excellent aesthetic result were generally the most important positive determinants in women's choices for a specific type of BR. However, short- and long-term complication rates of 20 and 30%, respectively, had a similar-sized negative effect on utility. Interestingly, waiting time hardly affected utility levels.

Based on women's preferences and realistic values for attributes, relative utility scores were calculated for several types of BR and subsequently ranked. Autologous BR (e.g., DIEP flap, extended LD transposition without implants) were awarded the highest utility scores by our study population and therefore seemed to fit in best with patients' preferences.

CONCLUSION

The studies presented in this thesis cover various aspects of autologous breast reconstructions. We showed DIEP flap BR to be a safe and reliable procedure in primary, secondary, as well as tertiary cases, yielding good results with high patient satisfaction after approximately 1.4 additional operations. Donor-site morbidity was generally limited. Compared to other procedures, short-term medical costs were highest after DIEP flap BR, but differences with TE/SP and bilateral LD transpositions were limited. Even though differences did not level out during follow-up, DIEP flap BR demonstrated its economic viability. Cost comparison alone does not seem a valid argument for treatment selection, especially if patients' preferences are taken into account. Patients revealed a strong preference for autologous material and an excellent aesthetic result and these attributes had the biggest positive effect on utility. However, short- and long-term complication rates potentially have a similar-sized negative effect on utility.

As reconstructive breast surgery is primarily aimed at satisfying the patient with respect to her own preferences and expectations, individualized selection of a reconstructive technique is paramount. To determine the most suitable option for an individual patient, multiple factors have to be considered. Professional assessment of technical feasibility,

acceptable risks, and obtainable aesthetic result is paramount. In addition, accurate patient information is of vital importance to allow patients to make a conscious and deliberate decision about BR and to have realistic expectations. Our results implicate that all patients are at least entitled to detailed information about autologous BR, even if that technique is not available in that particular institute or is not offered by that particular plastic surgeon.

Nederlandse samenvatting

Borstreconstructies hebben tot doel om de geamputeerde borst te herstellen en daardoor de kwaliteit van leven en het lichaamsbeeld van patiënten na een mastectomie te verbeteren. Er zijn grofweg drie verschillende methoden om een borstreconstructie uit te voeren. Er kan gebruik worden gemaakt van kunstmateriaal (prothesen), lichaamseigen weefsel of een combinatie daarvan. Technieken verschillen onder andere van elkaar ten aanzien van het materiaal dat wordt gebruikt, de duur van de operatie(s), de herstelperiode, complicatie percentages, het cosmetisch resultaat en de kosten. Elke techniek heeft voor- en nadelen en daardoor zijn eigen plek binnen de huidige praktijk. Borstreconstructies kunnen tijdens dezelfde operatie als de mastectomie worden uitgevoerd (directe of primaire reconstructie) of op een later tijdstip (secundaire reconstructie).

In 2002 werd de deep inferior epigastric perforator (DIEP) lap geïntroduceerd in het Erasmus Medisch Centrum in Rotterdam en groeide al snel uit tot de voorkeursmethode voor autologe borstreconstructies. De studies in dit proefschrift werden uitgevoerd om een overzicht te geven van verschillende technische, psychologische en economische aspecten van deze vorm van borstreconstructies.

TECHNISCHE ASPECTEN

In **hoofdstuk 2** worden de klinische resultaten van onze eerste 175 DIEP lap borstreconstructies gepresenteerd. In 159 gevallen (91%) kon een DIEP lap worden geoogst, terwijl in 13 gevallen peroperatief werd gekozen voor een mini-TRAM lap (7%) en in 3 gevallen voor een reguliere TRAM lap (2%). Kritische analyse van per- en postoperatieve problemen toonde een significante afname van het aantal complicaties na de eerste 30 lappen in 23 patiënten. Het percentage lapcomplicaties nam af van ongeveer 40% naar minder dan 15%; deze afname weerspiegelt onze leercurve. In 4% van de patiënten was een microchirurgische revisie noodzakelijk. In 1% van de patiënten trad een totaal verlies van de lap op, terwijl 9% een gedeelte van hun lap verloor. Gedeeltelijk verlies van de DIEP lap werd verholpen door debridement, het naar mediaal doorvoegen van de lap en primair sluiten in 7% of een latissimus dorsi transpositie in 2%. Er werd een multivariate analyse verricht naar de relatie tussen het optreden van lap en donorplaats complicaties en verschillende risicofactoren en patiënt karakteristieken. Er werd geen significante relatie gevonden tussen DIEP lap complicaties en roken, diabetes mellitus, hypertensie, overgewicht (BMI > 30 kg/m^2), zwangerschap, radiotherapie of eerdere buikoperaties. Er was een trend zichtbaar dat roken en diabetes een negatief effect hadden op DIEP lap complicaties. Abdominale complicaties waren alleen significant gerelateerd aan diabetes en hypertensie.

In **hoofdstuk 3** worden de perioperatieve beslissingen ten aanzien van de soort lap, de donor en acceptorvaten en de behandeling van vroege complicaties beschreven aan de hand van de persoonlijke ervaringen van een plastisch chirurg met 406 microchirgische borstreconstructies. Het resultaat van de reconstructie wordt voor een groot deel bepaald door deze beslissingen. In 88% van de gevallen (n = 359) werd een DIEP lap geoogst, in 11% (n = 44) een spiersparende TRAM lap en in 1% (n = 3) een fasciesparende TRAM lap. De DIEP lap had in 48% (n = 171) één perforator en in 52% (n = 188) twee of meer perforatoren, met gemiddeld twee perforatoren per lap. De arteria en vena mammaria

interna werden overwegend als acceptorvaten gebruikt (99%; n = 403). In 11% van de lappen (n = 48) was aanvullende veneuze afvloed benodigd. Gedeeltelijk verlies van de lap trad op in 9 gevallen, totaal verlies van de lap in 2 gevallen. Op basis van deze ervaringen werden algoritmes gemaakt voor het kiezen van de soort lap, het behandelen van veneuze stuwing en gedeeltelijk of totaal verlies van de lap. Deze algoritmes kunnen het besluitvormingsproces vergemakkelijken en hopelijk het succespercentage van microchirurgische borstreconstructies verder verhogen.

Borstreconstructies worden over het algemeen in meerdere etappes uitgevoerd. **Hoofdstuk 4** beschrijft de aanvullende operaties die na de initiële DIEP lap borstreconstructie werden uitgevoerd om het eindresultaat te verbeteren of complicaties te verhelpen. Tweeënzeventig patiënten die hun borstreconstructie inmiddels hadden afgerond, werden geïdentificeerd in onze database. Er waren gemiddeld 1,4 aanvullende operaties nodig om een voor de patiënt bevredigend cosmetisch resultaat te bereiken. Patiënten met een complicatie ondergingen gemiddeld 1,9 aanvullende operaties, vergeleken met 1,2 operaties voor patiënten zonder complicaties. Er was geen relatie tussen het optreden van complicaties en het aantal aanvullende cosmetische ingrepen of de keuze voor tepelreconstructie. Procedures die het vaakst werden uitgevoerd waren tepelreconstructies, het verbeteren van de vorm van de gereconstrueerde borst, littekencorrecties en procedures ter symmetrisatie van de contralaterale borst.

Voor de meeste borstreconstructies wordt gebruik gemaakt van kunstmateriaal. Op de lange termijn worden deze reconstructies vaak gecompliceerd door kapselvorming, waardoor de prothese vervangen of zelfs verwijderd moet worden, of waardoor chronische pijnklachten of een strak gevoel kunnen ontstaan. Er is een toenemende vraag van vrouwen om hun niet-succesvolle prothese reconstructie om te zetten naar een reconstructie met lichaamseigen weefsel. Borstreconstructies bij vrouwen die eerder een andere vorm van borstreconstructie hebben ondergaan, worden tertiaire reconstructies genoemd. In **hoofdstuk 6** hebben we de technische en psychologische uitkomst geëvalueerd van tertiaire autologe borstreconstructies in 42 patiënten. Zowel DIEP lappen (n = 47), mini-TRAM lappen (n = 10) als TMG lappen (n = 4) werden geïncludeerd. Het complicatie percentage was vergelijkbaar met dat na primaire of secundaire borstreconstructies. Tertiaire autologe borstreconstructies blijken technisch haalbaar en betrouwbaar. Littekens van eerdere operaties en complicaties maken tertiaire reconstructies potentieel erg uitdagend.

PSYCHOLOGISCHE ASPECTEN

De kwaliteit en effectiviteit van een borstreconstructie kan niet alleen worden uitgedrukt in klinische uitkomstmaten zoals het complicatiepercentage. Patiëntentevredenheid en de impact van de ingreep op de kwaliteit van leven moeten ook in ogenschouw worden genomen, waarbij het verwachtingspatroon van een patiënt ook erg belangrijk is. Deze en andere psychologische aspecten, zoals lichaamsbeeld en seksualiteit, komen aan bod in **hoofdstuk 4 t/m 6**.

In **hoofdstuk 4** hebben we het aantal aanvullende operaties gerelateerd aan de patiëntentevredenheid, welke met behulp van een studie-specifieke vragenlijst

werd gescoord. Patiënten waren erg tevreden met het eindresultaat van hun DIEP lap borstreconstructies en gaven een gemiddeld rapportcijfer van 8 (op een schaal van 1 tot 10). Tevredenheid over symmetrie, littekens op de gereconstrueerde borst en tepel/tepelhof waren het belangrijkste en hadden een positieve invloed op de algehele tevredenheid. Patiënten die een tepelreconstructie hadden ondergaan, waren net zo tevreden over het eindresultaat als patiënten zonder een tepelreconstructie. Hetzelfde gold voor patiënten met een gecompliceerd en een ongecompliceerd beloop.

In **hoofdstuk 5** hebben we ons verder verdiept in patiëntentevredenheid en de invloed van de ingreep op lichaamsbeeld, seksualiteit en kwaliteit van leven. Deze aspecten weren met behulp van een studie-specifieke vragenlijst en de Short Form-36 (SF-36) bestudeerd in 72 vrouwen die een DIEP lap borstreconstructie hadden ondergaan. Patiënten waren wederom erg tevreden met het eind resultaat van hun DIEP lap borstreconstructies en gaven een gemiddeld rapportcijfer van 8. Ongeveer 90 procent van de respondenten gaven aan dat ze voldoende waren geïnformeerd over de operatie, dat aan preoperatieve verwachtingen was voldaan, dat de gereconstrueerde borst lichaamseigen aanvoelt en dat ze deze ingreep opnieuw zouden kiezen en zouden aanbevelen aan een vriendin.

Patiëntentevredenheid was positief en significant gerelateerd aan de tevredenheid met kleding aan, het niet hebben van aanhoudende klachten over de reconstructie en het lichaamseigen aanvoelen van de gereconstrueerde borst. Het percentage vrouwen dat *erg* tevreden was nam geleidelijk af naarmate de kleding minder verhullend werd. Dit bevestigd dat er in intiemere situaties hogere eisen worden gesteld aan het resultaat van de borstreconstructie. Vrouwen met secundaire reconstructies ervoeren veranderingen ten aanzien van seksualiteit en vrouwelijkheid positiever dan vrouwen die een primaire reconstructie hadden ondergaan. Er waren geen klinisch relevante verschillen ten aanzien van de kwaliteit van leven tussen onze studie populatie en een willekeurige steekproef Nederlandse vrouwen.

De belangrijkste redenen om voor een tertiaire autologe reconstructie in aanmerking te willen komen, waren fysieke klachten van de implantaten en ontevredenheid over het cosmetische resultaat (**hoofdstuk 6**). Bij het overgrote merendeel van de patiënten namen de fysieke klachten af of verdwenen ze zelfs. De meeste patiënten waren erg tevreden met het cosmetische resultaat (gemiddeld rapportcijfer 8) en volgens een panel van experts was er een significante verbetering van het cosmetisch resultaat na conversie naar een autologe reconstructie (gemiddeld rapportcijfer van 5 naar 7).

ECONOMISCHE ASPECTEN

In **hoofdstuk 7** hebben we de intramurale medische kosten op korte en middellange termijn van 4 verschillende borstreconstructies (prothese (SP), tissue expander gevolgd door prothese (TE/SP), latissimus dorsi transpositie met of zonder prothese (LD ± SP), DIEP lap) vergeleken. Ook de extramurale medische en niet-medische kosten zijn in deze studie meegenomen. De intramurale medische kosten werden geëvalueerd binnen een prospectieve, historische cohort studie van 427 patiënten die tussen 2002 en 2009 een borstreconstructie hadden ondergaan. De extramurale medische en niet-medische kosten

zijn prospectief in kaart gebracht met behulp van een gestandaardiseerde vragenlijst. Aan deze studie namen 58 patiënten deel.

Op korte termijn waren de intramurale medische kosten het hoogst na DIEP lap borstreconstructies (unilateraal €12.848, bilateraal €15.747), maar het verschil met TE/SP reconstructies (€12.400; €12.723) was beperkt. Bilaterale LD transposities (€10.760) waren overwegend in twee tempi uitgevoerd en daardoor bijna twee keer zo kostbaar als unilaterale LD transposities (€5.804). Prothese reconstructies waren het goedkoopst (€4.731; €6.784). De bijkomende kosten voor complicaties en aanvullende operaties op de middellange termijn verschilden niet significant tussen de diverse technieken (€3.017 – €4.503). Tijdens onze follow-up van meer dan 5 jaar bleven de verschillen in intramurale medische kosten bestaan. De extramurale medische kosten en niet-medische kosten bedroegen ongeveer €9.300 per stadium, los van de operatieve techniek.

In onze serie waren prothese reconstructies het goedkoopste, zowel op de korte als op de middellange termijn. Deze techniek kent echter hoge complicatiepercentages en is daardoor niet geschikt voor alle patiënten. Alleen in bepaalde gevallen wordt deze techniek aanbevolen. Tegenwoordig worden prothese reconstructies steeds vaker voorafgegaan door weefselexpansie, waardoor de kosten redelijk vergelijkbaar worden met die van autologe reconstructies. Als niet-medische kosten in de analyse worden meegenomen zouden reconstructies in 2 tempi zelfs duurder worden dan autologe reconstructies.

In **hoofdstuk 8** hebben we (de determinanten van) de voorkeuren van patiënten voor verschillende borstreconstructies in kaart gebracht met behulp van een discreet keuze experiment (discrete choice experiment, DCE). Met een DCE kan het relatieve belang van karakteristieke eigenschappen van de verschillende operaties worden geanalyseerd en kunnen de afwegingen die patiënten hiertussen maken worden bestudeerd. Deze informatie stelt ons in staat om inzicht te krijgen in de voorkeuren van patiënten (consumenten), die een belangrijke rol spelen bij de keuze voor een bepaald soort reconstructie. Begrip voor en kennis van de motivatie van vrouwen kan er toe bijdragen dat patiëntenvoorlichting wordt verbeterd, de gezondheidszorg meer patiëntgericht wordt en vraag en aanbod beter op elkaar zijn afgestemd.

Voor deze studie werden 386 patiënten benaderd die in het verleden een therapeutische of profylactische mastectomie hebben ondergaan al dan niet gevolgd door een borstreconstructie. Respondenten kregen bij herhaling een keuze voorgelegd tussen verschillende behandelmogelijkheden, waarvan ze de optie moesten kiezen die hen het meeste aansprak. Borstreconstructies werden gekarakteriseerd door 6 attributen: 1) het materiaal dat wordt gebruikt voor de reconstructie; 2) het aantal en de duur van de operatie(s); 3) korte en 4) lange termijn complicaties; 5) cosmetisch resultaat; 6) wachtlijst.

Alle attributen bleken van belang voor de keuze van vrouwen. Autoloog weefsel en een uitstekend cosmetisch resultaat bleken de belangrijkste positieve determinanten te zijn. Korte en lange termijn complicaties van 20 respectievelijk 30 procent hadden een vergelijkbaar, maar negatief effect op de utiliteit. Opvallend genoeg was het effect van de wachtlijst op de utiliteit bijna verwaarloosbaar.

Door uit te gaan van deze voorkeuren van vrouwen en door realistische waarden in te vullen voor de verschillende attributen konden relatieve utiliteitscijfers worden berekend voor verschillende technieken. Deze uitkomsten werden vervolgens gerangschikt. Autologe reconstructies (bijv. DIEP lap, verlengde LD transpositie zonder prothese) kregen

van onze studiepopulatie de hoogste utiliteitsscores toebedeeld en lijken daardoor het beste aan te sluiten op de voorkeuren van patiënten.

CONCLUSIE

De studies uit dit proefschrift beschrijven verschillende aspecten van autologe borstreconstructies. We hebben aangetoond dat DIEP lap borstreconstructie een veilige en betrouwbare techniek is, zowel voor primaire, secundaire als tertiaire reconstructies. Het cosmetische resultaat is goed en na gemiddeld 1,4 aanvullende operaties zijn patiënten zeer tevreden. De donorplaats morbiditeit was over het algemeen beperkt. De intramurale medische kosten waren op de korte termijn hoger voor DIEP lap borstreconstructies dan voor andere technieken, maar de verschillen met TE/SP reconstructies en bilaterale LD transposities waren beperkt. Ondanks het feit dat deze verschillen gedurende onze follow-up niet verdwenen, hebben we de economische levensvatbaarheid van DIEP lap borstreconstructies gedemonstreerd. De keuze voor een bepaalde vorm van borstreconstructie kan niet uitsluitend worden gemaakt op basis van de kosten, zeker niet als we de voorkeuren van patiënten in ogenschouw nemen. Patiënten hadden een uitgesproken voorkeur voor het gebruik van autoloog weefsel en een uitstekend cosmetisch resultaat en deze attributen leverden de belangrijkste positieve bijdrage aan de utiliteit. Korte en lange termijn complicaties kunnen dit positieve effect echter teniet doen.

Het voornaamste doel van reconstructieve borstchirurgie is om patiënten tevreden te stellen ten aanzien van hun eigen voorkeuren en verwachtingen. Individuele selectie van een operatietechniek is daarvoor essentieel. Om de meest geschikte methode voor een individuele patiënt te bepalen, moeten meerdere factoren afgewogen worden. De professionele inschatting van technische haalbaarheid, complicatierisico's en mogelijk cosmetisch resultaat spelen hierbij vanzelfsprekend een grote rol. Daarnaast is gedetailleerde patiëntenvoorlichting noodzakelijk om patiënten een bewuste en weloverwogen beslissing te kunnen laten nemen en een realistisch verwachtingspatroon te krijgen. Onze resultaten impliceren dat alle patiënten in ieder geval recht hebben op uitgebreide informatie over autologe borstreconstructies, ook als die techniek in het desbetreffende ziekenhuis of door de desbetreffende plastisch chirurg niet aangeboden wordt.

Appendices

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Curriculum vitae

Tim Herman Cornelis Damen was born on July 29th, 1979 in Berkel-Enschot, the Netherlands. At the age of 6 his family moved to Capelle aan den IJssel. He attended the Emmaus College in Rotterdam. After graduating in 1997, he enrolled into medical school at Utrecht University. On completing his theoretical exams in 2001, he took a gap year to become a board member of the student society MSFU "Sams". He obtained his medical degree in 2005, and started as a house officer at the department of Plastic, Reconstructive and Hand Surgery of the Erasmus Medical Centre (prof.dr. S.E.R. Hovius). During his clinical work he became involved with the research described in this thesis under supervision of dr. S.O.P. Hofer and dr. M.A.M. Mureau. When accepted for the plastic surgery training programme, he continued this research project as a full-time Ph.D.-student for just over 2 years. His research involved him working closely with the department of Social Medicine (dr. M.L. Essink-Bot). In December 2008 he started his two year general surgery training at the Ikazia Hospital in Rotterdam (dr. W.F. Weidema, dr. P.T. den Hoed), after which he visited St. Thomas' Hospital, London, United Kingdom (dr. J. Farhadi) for 3 months. He is currently continuing his specialist training at the department of Plastic, Reconstructive and Hand Surgery of the Erasmus Medical Centre in Rotterdam (prof.dr. S.E.R. Hovius, dr. L.N.A. van Adrichem). Tim is married to Joanna Damen-Wendholt and they have two daughters, Anouk and Kaia.

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Hofer SOP, **Damen THC**, Mureau MAM, Rakhorst HA, Roche NA. A critical review of perioperative complications in 175 free deep inferior epigastric perforator flap breast reconstructions. Ann Plast Surg 2007: 59: 137-42.

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Damen THC, Wei W, Mureau MAM, Tjong-Joe-Wai R, Hofer SOP, Essink-Bot ML, Hovius SER, Polinder S. Medium-term cost-analysis of breast reconstructions in a single Dutch centre: A comparison of implants, implants preceded by tissue expansion, LD transpositions and DIEP flaps. J Plast Reconstr Aesthet Surg 2011; 64: 1043-53.

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Enajat M, **Damen THC**, Geenen A, Timman R, Van der Hulst RRWJ, Mureau MAM. Pulmonary embolism after abdominal flap based breast reconstruction: an integrated approach of prediction, prevention and treatment. Plast Reconstr Surg, submitted.

PhD portfolio summary

Summary of PhD training and teaching activities

Name PhD student: T.H.C. Damen
Erasmus MC Department: Plastic, Reconstructive and Hand Surgery
PhD period: October 1st, 2006 – November 30th, 2008
Promotor: Prof.dr. S.E.R. Hovius
Supervisor: Dr. M.A.M. Mureau, Dr. M.L. Essink-Bot

1. PhD training		
	Year	Workload
General academic skills		
– Biomedical English writing and communication	Self taught	n.a.
Research skills		
– CPO minicursus: Methodologie van patiëntgebonden onderzoek en voorbereiding van subsidieaanvragen	2006	5 hours
– Good Clinical Practice; Nihes, Rotterdam	2007	5 days
– Biostatistics for Clinicians; Nihes, Rotterdam	2008	1 ECTS
– Introduction to Clinical Research; Nihes, Rotterdam	2008	0.9 ECTS
In-depth courses		
– Microsurgery course, Skillslab, Rotterdam	2006	24 hours
– Nerve reconstruction course, Skillslab, Rotterdam	2008	8 hours
Presentations		
– Kritische evaluatie van perioperatieve complicaties bij 175 borstreconstructies met een vrije DIEP lap; NVPC	2007	20 hours
– Hoge patiëntentevredenheid na DIEP lap borst-reconstructie; NVPC	2008	20 hours
– Bevredigend eindresultaat na DIEP lap borstreconstructies: een overzicht van de aanvullende operaties; NVPC	2008	20 hours
– Patients' preferences for breast reconstruction: a Discrete Choice Experiment; NVPC	2009	20 hours
– Patients' Preferences for Breast Reconstruction: a Discrete Choice Experiment; ASRM, Hawaii, USA (poster).	2009	6 hours
– De kosten van borstreconstructies: een vergelijkende studie van technieken; NVPC	2010	20 hours
International conferences		
– WSRM, Athens, Greece	2007	30 hours
– Combined meeting of NVPC and RBSPS, Knokke, Belgium	2006	12 hours
Seminars and workshops		
– Kortjakje Zondagsschool (2x/jaar)	2006-2011	20 hours
– Wondcongres	2007-2009	16 hours

	Year	Workload
Other		
– Avond- en weekenddiensten plastische chirurgie	2005-2008	n.a.
– Diverse projecten binnen Ruimte voor Nieuw	2006-2008	120 hours
– Kostprijsberekeningen en -onderhandelingen DIEP lap borstreconstructie	2007	30 hours
– Oefenen microchirurgische vaardigheden	2005-2008	160 hours

2. Teaching activities		
	Year	Workload
Lecturing, supervising practicals and excursions		
– Regulier onderwijs 2e en 3e jaars geneeskunde studenten	2006-2008	20 hours
– Keuzeonderwijs Craniofaciaal en Bovenste extremiteit voor 3e jaars studenten	2007-2008	50 hours
– Coach basiscursus microchirurgie; Skillslab, Rotterdam	2006-2008	50 hours
– Coach gevorderden cursus microchirurgie; Skillslab, Rotterdam	2007-2008	30 hours
– Hechtcursussen keuzeonderwijs en artikel 9 cursus	2007-2008	30 hours
– Hechtcursus Erasmus weekend school	2008	4 hours
Supervising research projects		
– Begeleiding onderzoeksstages medisch studenten (Wu Wei en Noortje Visser)	2007-2009	50 hours
Other		
– Bijdrage aan organisatie New Frontiers in Arthroscopic Wrist Surgery, Esser Master Class	2007	3 days
– Bijdrage aan organisatie Hand Flap Surgery and Wrist Surgery, International Dissection Course	2007	2 days