New Clinical Concepts in Inguinal Hernia

Nieuwe klinische benaderingen in de behandeling van de liesbreuk

Ruben Nico van Veen

Cover: Jens A. Halm, titel “Licht, lucht en ruimte”
Huis Sonneveld, Rotterdam
Brinkman en Van der Vlugt, de architecten van de Van
Nellefabriek, ontwierpen het huis voor een van de directeuren, de heer
A.H. Sonneveld, begin dertiger jaren. De villa is een monument in de stijl van
het Nieuwe Bouwen.

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Chapter 1

Introduction and Outline of the Thesis

R.N. van Veen

Introduction

Hernia surgery is one of the earliest forms of surgery and currently the most frequently performed operation in general surgery. Relatively modest improvements of clinical outcomes or savings of resource use in inguinal hernia repair would already have a significant medical and economical impact.[1]

Anatomy

A groin or inguinal hernia is an abdominal wall defect with or without evident 'bulging' or protrusion of abdominal contents in the inguinal area. Inguinal hernias protrude though the anatomic weakness in the abdominal wall of the groin area, termed the myopectineal orifice of Fruchaud (triangle of Fruchaud) bounded by the arch of the oblique and transverse abdominal muscles cranially, the iliopsoas muscles laterally, the rectus abdominis muscle medially and the pubic pectin caudally. The complexity of the anatomy, variety in size and location of the defect, and multiplicity of the hernia presentation have contributed to this uncertainty regarding an optimal repair.

Fruchaud's triangle is entirely covered by the transversalis fascia. The inferior epigastric vessels originate from the external iliac vessels at the dorsal boundary of the deep inguinal ring and represent the lateral border of Hesselbach's triangle. The medial border consists of the lateral aspect of the rectus abdominis muscle while the inguinal ligament (Poupart) serves as caudal boundary.

Important nerves with regard to anterior (ventral) inguinal hernia repair are the iliohypogastric nerve, the ilio-inguinal nerve and the genital branch of the genitiofemoral nerve. The nerves implicated in the posterior (dorsal) repair are all located in the so-called triangle of pain: the femoral branch of the genitofemoral nerve, the femoral nerve and its cutaneous branch as well as the lateral femoral cutaneous nerve.

Incidence and risk factors

Groin hernia repair is the most frequently performed operation in general surgery. Approximately 800.000 repairs are performed in the USA and 33.000 in The Netherlands annually.[2,3] The health effects of inguinal hernia on the community are tremendous, since people apparently are at high risk for the development of inguinal hernia. According to

a recent report from the United States, the cumulative incidence of hospital admissions with inguinal hernia was 13.9 per cent for men and 2.1 per cent for women after a median follow up 18.2 years.[4] The risk of inguinal hernia increases with age, reaching 22.8 per cent in persons aged 60-74 year.[4]

Risk factors that have been implicated in the etiology of inguinal hernias are: smoking,[5] disturbed collagen synthesis,[6] chronic obstructive pulmonary disease (COPD),[7] and patent processus vaginalis (PPV).[8]

In childhood indirect inguinal hernias arise from incomplete obliteration of the processus vaginalis, the embryological protrusion of peritoneum that precedes testicular descent into the scrotum. The testes originate along the urogenital line in the retroperitoneal space and migrate during the second trimester of pregnancy to the internal inguinal ring. During the last trimester these proceed through the abdominal wall via the inguinal canal and descend into the scrotum, the right slightly later than the left.[9] The processus vaginalis extends from the inguinal ring superiorly, medially, and anteriorly to the cord structures and to the uppermost portion of the tunica vaginalis. The cord in the male and the round ligament in the female curve laterally and anteriorly to the inferior epigastric vessels.[10] The processus vaginalis normally obliterates postnatally except for the part covering for the testes.[1] Failure of this obliterative process results in a patent processus vaginalis (PPV), a possible congenital indirect inguinal hernia.[11]

Clinical signs, diagnosis and classification

Clinically a groin hernia is diagnosed as a bulge in the inguinal area above Poupart's ligament; sometimes accompanied by mild pain and/or discomfort. Patients experience severe pain only in incarcerated and strangulated hernias.

Previously, the cumulative probability of strangulation for inguinal hernia was reported to be 2.8 per cent at 3 months after presentation, rising to 4.5 per cent after 2 years.[12] In contrast, a recent study calculated that the lifetime risk of strangulation for an 18-year-old with an inguinal hernia is 0.272 per cent and 0.034 per cent for a 72-year-old.[13] In a prospective nation wide survey including 26,304 herniorrhaphies in Denmark, operative mortality associated with elective inguinal hernia repair was about 0.22 per cent.[14]

Diagnosis of inguinal hernia is achieved by physical examination. The protrusion can usually be reduced manually and provoked by Valsalva's maneuver. Differentiating between a medial (direct) and lateral (indirect) hernia during physical examination is not reliable.[15,16]

Differential diagnosis of a mass in the inguinal area include: groin hernia or recurrence, femoral hernia, lymph node, aneurysm of iliac arteries, varix of the saphenous vein,

psoas abces and malignancy.

In case of uncertainty of the diagnosis inguinal hernia, additional imaging modalities like ultrasound, herniography, CT scan and MRI are available. Herniography and MRI have the highest sensitivity and specificity of all diagnostic modalities. Sensitivity of herniography is between 81-100% and specificity between 92-98% in patients without a palpable swelling.[16,17] MRI has a sensitivity of 94.5% and a specificity of 96.3% in diagnosing inguinal hernia.[18] Ultrasound, with a sensitivity of 85% and a specificity of 93%, is a reasonable alternative in the diagnosis of inguinal hernia in patients presenting with an unknown tumor of the groin.[19]

Classification

Hasselbach's triangle is bordered on the medial side by the rectus sheath, on the craniolateral side by the epigastric vessels and in the inferior side by the inguinal ligament (Poupart). An indirect inguinal hernia is situated laterally to Hesselbach's triangle and thus laterally to the epigastric vessels. The peritoneal sac protrudes through the internal inguinal ring and passes down the inguinal canal together with the spermatic cord.

A direct inguinal hernia protrudes through the floor of the inguinal canal in Hesselbach's triangle, medially to the epigastric vessels.

Nyhus has described a classification for inguinal hernia.[20] The classification combines type of herniation, anatomical aspects of the posterior wall and aspects of the internal ring. The hernia is described from an intra-abdominal point of view. Classifications are: type I (indirect hernia, normal internal ring), II (indirect hernia; dilated internal ring), III A (direct hernia; defect posterior wall), III B (combined hernia; dilated internal ring and defect posterior wall), III C (femoral hernia; normal internal ring, normal posterior wall) and type IV (recurrent hernia; direct, indirect and combined).

Anaesthesia

In 2003 evidence-based guidelines for the treatment of inguinal hernia in adults were developed in the Netherlands.[21] The main recommendations of these guidelines were to use a mesh-based repair technique in adult patients as previous studies of our research group also has demonstrated and to consider local anesthesia when performing open anterior repair.[22,23] Currently only seven per cent of all inguinal hernia repairs in the Netherlands are carried out under local anesthesia. Forty per cent of anesthesiologists in the Netherlands prefer to use spinal anesthesia, which may lead to the following adverse effects: headache, urinary retention, motor block of lower extremities, intraoperative

hypotension, and delayed mobility resulting in a delayed release from hospital.[24]

Several studies indicate that local infiltration anesthesia for inguinal herniorrhaphy blocks surgical stress effectively, provides extended postoperative analgesia, is simple to execute and safe for high-risk patients. In addition patients are able to mobilise early without postanesthesia side effects and less groin pain.[14,25-29]

Local anesthesia is preferred at centers with a special interest in hernia repair,[28,30] whereas in general surgical units regional or general anesthesia is more often used.

Treatment

Non-mesh repair

Bassini performed the first inguinal hernia repair with reconstruction of the floor of the inguinal canal to preserve functional anatomy in 1884, firstly described in 1887.[31] The operation involved high ligation of the hernia sac by opening the transversalis fascia and consequently suturing the internal oblique and transverse abdominis muscles, together with the upper leaf of the transversalis fascia (triple layer), to the inguinal 'Poupart's' ligament and the lower leaf of the transversalis fascia. Interrupted silk sutures were used. This technique dramatically decreased postoperative mortality, morbidity and recurrence rate. In 2001, still 7.7% of primary inguinal hernias repairs were corrected by a (modified) Bassini technique in The Netherlands.[24]

In 1940 McVay popularized a method first described by Lotheissen. The conjoint tendon was sutured to the pectineal 'Cooper's' ligament instead of to the inguinal ligament.[32,33]This method is based on the observation that the conjoint tendon originally is attached to Cooper's ligament.

Shouldice[34] described a multi-layer repair based on Bassini's repair, which is probably the most successful method of non-mesh repair.[1,35] Stainless steel continuous sutures are applied. The transversalis fascia is opened exposing the internal ring and widely dissected from the preperitoneal fat. The first layer of the repair involves suturing the lower flap of the transversalis fascia to the posterior side of the upper flap of this fascia and to the posterior side of the rectus abdominis muscle. The upper flap of the transversalis fascia is sutured to the base of the lower flap and to the inguinal ligament forming the second layer. The third layer consist of the conjoint tendon sutured to the inguinal ligament and lower flap of the external oblique aponeurosis. For the fourth layer, the anterior rectus sheath and the lower aspects of the conjoint tendon from the front to the inner surface of the lower flap of the external oblique aponeurosis are sutured. The external oblique aponeurosis is now closed over the spermatic cord. This repair is technically complex

and therefore time consuming.

These three types of non-mesh repair represent the most widely used surgical procedures for inguinal hernia repair without use of prosthetic material. Although many other methods have been described, the common problem of these techniques is that suturing and displacement of anatomic structures may cause excessive tension on the suture line and surrounding tissue, thus increasing the risk of recurrence of hernia.

Recurrence rates of non-mesh repair vary from 0 to 33% depending on the surgical method, experience with the technique, length of follow-up and type of hospital.[23]

Mesh repair

Abdominal wall hernia repair with the use of polypropylene mesh was initially described by Usher in 1956, introducing a polypropylene mesh 'Marlex 50'.[36] Hernia repair employing polypropylene mesh to achieve 'tension-free' repair was first described by Lichtenstein and adjusted by Amid.[37] This technique avoids tension on the sutured structures bordering the defect by refraining from approximating these structures. The Lichtenstein technique involves dissecting and inverting the hernia sac without opening it. Closure of the hernial orifice is not attempted. The defect is covered with a mesh sized about 7x16 cm trimmed to fit the area with 2 cm overlap of the tuberculum pubis and 3 cm overlap of Hesselbach's triangle. A slit in the mesh on the lateral side, 1/3 caudally and 2/3 cranially from the internal ring, allows emergence of the spermatic cord and vessels. The two lateral tails of the mesh are crossed and sutured with non-absorbable material to embrace the spermatic cord and vessels thus creating a new internal ring. A non-absorbable suture is used to fix the mesh on the inguinal ligament. Two absorbable sutures are used to fix the mesh cranially. The external oblique aponeurosis is closed over the mesh. It must be addressed that the Lichtenstein technique is nerve sparing, although not always performed in general practice.[38]

Other types of repair with prosthetic mesh are for example Gilbert's plug and patch repair[39] which has been modified by Robbins and Rutkow[40] and the Rives', Stoppa,[41] Wantz[42] and Kugel[43] repairs involving mesh placement of a mesh preperitoneally. These repairs will not be discussed in this thesis, although the open preperitoneal techniques led to the development of the endoscopic preperitoneal repair.

Endoscopic repair

In 1982, under laparoscopic guidance, Ger and collegues[44] used a Michel staple applied with a Kocher clamp to close the preperitoneal opening of a hernia sac. A new hernia repair technique was introduced.

Posterior inguinal hernia repair can be executed by totally extraperitoneal repair (TEP), transabdominal preperitoneal repair (TAPP) and with an intraperitoneal onlay

mesh (IPOM).[45] The avoidance of the three inguinal nerves.is a theoretical advantage of these techniques.
TEP seems to be associated with a shorter hospital stay and earlier return to work compared to open inguinal hernia repair.[46]

The Dutch hernia guideline advises repair of bilateral inguinal hernia through TEP if the necessary expertise is available. Furthermore the guidelines suggest that TEP in patients with bilateral hernia is more cost effective and leads to faster recovery than anterior mesh surgery.[21]

On the other hand, endoscopic hernia repair requires special skills to overcome limitations inherent to this type of surgery, such as loss of depth perception, a limited range of motion and reduced tactile feedback. As a consequence, it has a significant learning curve[47,48] and is associated with prolonged operating times.[49] Furthermore, some serious complications including vascular damage, nerve injury, bowel obstruction and bladder perforation[50] have been reported during laparoscopic transabdominal preperitoneal (TAPP) mesh repair.[51-53]

Pain

The use of prosthetic mesh allows tension-free inguinal hernia repair and has proven to result in less recurrences. Concomitantly with popularisation of this repair, it has become clear that morbidity associated with this operation mainly consists of chronic groin pain. Randomized studies investigating chronic groin pain after open mesh versus non-mesh hernia repair on the long-term after 5 years do not exist.

The incidence of postoperative chronic pain after open herniorraphy is high.[3,54] The most common types of postoperative chronic pain are reported to be of somatic and neuropathic origin.[55,56]

Views on whether or not to identify and subsequently divide or preserve the three inguinal nerves together or separately during open herniorraphy are diverse. Lichtenstein and his successor Amid recommend preservation of the inguinal nerves whereas Wantz et al. recommended intentional severance based on the concept of ‘no nerve, no pain’.[57-59]

Chronic exercise-related groin pain can be a debilitating condition, particularly in athletes. It is a common cause of chronic groin pain in athletes, together with osteitis pubis, stress injury involving the pubic bones, intra-articular hip abnormality, urological diseases, nerve entrapment, and origin lesions of the adductor muscle.[60-63] Sports which require repetitive kicking, evasive or side-to-side motion, and physical contact seem to be more commonly affected by this condition.[61,64] It is particularly common in soccer and hockey players and can result in significant reduction in playing time.[60,65,66] The number of sports-related injuries have increased as a function of increased athletic activities and

the demand for an early return to normal sports activities puts pressure on the doctor for immediate diagnosis and treatment.[67]
Giving support to the theory that posterior weakness is the prime cause of groin pain in athletes, a mesh is placed endoscopically, resolving the problem of the posterior weakness in the inguinal wall.[68]

Long-term follow-up

Recurrence rates after non-mesh suture repair of inguinal hernia vary between 0.2 and 33 per cent, depending on surgical method, experience, type of hospital and length of follow-up.[1,35,69-74] Recurrence rates currently represent the most important endpoint in hernia surgery, but data on long-term rates of recurrence in mesh techniques are hardly available.[75] Follow-up of recurrence rates after 10 years needs to be assessed.

Aim of this thesis

This thesis comprises several studies which discuss specifically ongoing clinical issues concerning etiology, type of anesthesia, pain during inguinal hernia surgery, postoperative pain and long-term evaluation of pain and recurrences.

Lichtenstein tension-free hernioplasty is the golden standard technique for primary inguinal hernia surgery in The Netherlands. Regional and general anesthesia are the anesthetic method of choice. To address the role of local infiltration anesthesia we compared this technique to spinal anesthesia and focused attention on early postoperative pain **(Chapter 2)**. Morbidity associated with inguinal hernia repair according to Lichtenstein mainly consists of chronic groin pain. A review was conducted to address the influence of peroperative inguinal nerve identification and subsequent division or preservation on the incidence of chronic postoperative pain **(Chapter 3)**. To determine influence of the introduction of mesh material on the incidence of chronic pain, we conducted a randomized double-blind study of open non-mesh versus mesh hernia repair **(Chapter 4)**. Long-term follow-up needs to be eveluated to determine risk factors for the development of inguinal hernia in adults **(Chapter 5)** and to investigate whether mesh repair is favourable in the long term with respect to recurrence **(Chapter 6)**.

Reduction of rate of recurrence has been the main incentive to develop new techniques. A systematic review was conducted of all published and non-published randomized controlled trials comparing endoscopic total extraperitoneal inguinal hernia repair (TEP) with open mesh and suture repair **(Chapter 7)**. Long-term rates of recurrence in TEP are

evaluated in **chapter 8**. In **Chapter 9** the role of TEP in athletes suffering from chronic groin pain is investigated. In **Chapter 10** the results of these studies were converged to draw our conclusions and set some directions for future management in inguinal hernia repair.

References

1. Simons MP, Kleijnen J, van Geldere D, et al. Role of the Shouldice technique in inguinal hernia repair: a systematic review of controlled trials and a meta-analysis. Br J Surg 1996; 83(6):734-8.
2. Rutkow IM. Demographic and socioeconomic aspects of hernia repair in the United States in 2003. Surg Clin North Am 2003; 83(5):1045-51.
3. (LMR) NMR. www.prismant.nl (Hospital statistics-procedures). Assessed April 18 2007.
4. Ruhl CE, Everhart JE. Risk factors for inguinal hernia among adults in the US population. Am J Epidemiol 2007; 165(10):1154-61.
5. Sorensen LT, Friis E, Jorgensen T, et al. Smoking is a risk factor for recurrence of groin hernia. World J Surg 2002; 26(4):397-400.
6. Lehnert B, Wadouh F. High coincidence of inguinal hernias and abdominal aortic aneurysms. Ann Vasc Surg 1992; 6(2):134-7.
7. Carbonell JF, Sanchez JL, Peris RT, et al. Risk factors associated with inguinal hernias: a case control study. Eur J Surg 1993; 159(9):481-6.
8. van Veen RN, van Wessem KJ, Halm JA, et al. Patent processus vaginalis in the adult as a risk factor for the occurrence of indirect inguinal hernia. Surg Endosc 2007; 21(2):202-5.
9. Brendan Devlin H KA, O'Dwyer PJ, Bloor K. Management of Abdominal Hernia's. 2nd ed. London: Chapman & Hall Medical 1998.
10. Kapur P, Caty MG, Glick PL. Pediatric hernias and hydroceles. Pediatr Clin North Am 1998; 45(4):773-89.
11. Abrahamson J. Etiology and pathophysiology of primary and recurrent groin hernia formation. Surg Clin North Am 1998; 78(6):953-72, vi.
12. Kingsnorth A, LeBlanc K. Hernias: inguinal and incisional. Lancet 2003; 362(9395):1561-71.
13. Fitzgibbons RJ, Richards AT, Quinn TH. 21 Open hernia repair. 2003.
14. Bay-Nielsen M, Kehlet H, Strand L, et al. Quality assessment of 26,304 herniorrhaphies in Denmark: a prospective nationwide study. Lancet 2001; 358(9288):1124-8.
15. Ralphs DN, Brain AJ, Grundy DJ, Hobsley M. How accurately can direct and indirect inguinal hernias be distinguished? Br Med J 1980; 280(6220):1039-40.
16. Hall C, Hall PN, Wingate JP, Neoptolemos JP. Evaluation of herniography in the diagnosis of an occult abdominal wall hernia in symptomatic adults. Br J Surg 1990; 77(8):902-6.
17. Loftus IM, Ubhi SS, Rodgers PM, Watkin DF. A negative herniogram does not exclude the presence of a hernia. Ann R Coll Surg Engl 1997; 79(5):372-5.
18. van den Berg JC, de Valois JC, Go PM, Rosenbusch G. Detection of groin hernia with physical examination, ultrasound, and MRI compared with laparoscopic findings. Invest Radiol 1999; 34(12):739-43.
19. Truong S, Pfingsten FP, Dreuw B, Schumpelick V. [Value of sonography in diagnosis of uncertain lesions of the abdominal wall and inguinal region]. Chirurg 1993; 64(6):468-75.
20. Nyhus LM. Individualization of hernia repair: a new era. Surgery 1993; 114(1):1-2.
21. Simons MP, de Lange D, Beets GL, et al. [The 'Inguinal Hernia' guideline of the Association of Surgeons of the Netherlands]. Ned Tijdschr Geneeskd 2003; 147(43):2111-7.
22. Vrijland WW, van den Tol MP, Luijendijk RW, et al. Randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia. Br J Surg 2002; 89(3):293-7.
23. van Veen RN, Wijsmuller AR, Vrijland WW, et al. Long-term follow-up of a randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia. Br J Surg 2007; 94(4):506-10.

24. de Lange DH, Aufenacker TJ, Roest M, et al. Inguinal hernia surgery in The Netherlands: a baseline study before the introduction of the Dutch Guidelines. Hernia 2005; 9(2):172-7.
25. Amid PK, Shulman AG, Lichtenstein IL. Local anesthesia for inguinal hernia repair step-by-step procedure. Ann Surg 1994; 220(6):735-7.
26. Callesen T, Bech K, Kehlet H. The feasibility, safety and cost of infiltration anaesthesia for hernia repair. Hvidovre Hospital Hernia Group. Anaesthesia 1998; 53(1):31-5.
27. Tverskoy M, Cozacov C, Ayache M, et al. Postoperative pain after inguinal herniorrhaphy with different types of anesthesia. Anesth Analg 1990; 70(1):29-35.
28. Kark AE, Kurzer MN, Belsham PA. Three thousand one hundred seventy-five primary inguinal hernia repairs: advantages of ambulatory open mesh repair using local anesthesia. J Am Coll Surg 1998; 186(4):447-55; discussion 456.
29. Ozgun H, Kurt MN, Kurt I, Cevikel MH. Comparison of local, spinal, and general anaesthesia for inguinal herniorrhaphy. Eur J Surg 2002; 168(8-9):455-9.
30. Amid PK, Shulman AG, Lichtenstein IL. Open “tension-free” repair of inguinal hernias: the Lichtenstein technique. Eur J Surg 1996; 162(6):447-53.
31. Bassini E. Nuovo metodo per la cura radicale dell’ernia inguinale. Atti Congr Associ Med Ital 1887; 2:179.
32. McVay CB, Halverson, K. Preperitoneal hernioplasty. New York NY: John Wiley and Sons, 1981.
33. Lotheissen G. Zur radikol operation der Schenkelhernien. Zentralbl Chir 1898; 23:548.
34. Shouldice EE. The treatment of hernia. Ontario Med Rev 1953; 20:670.
35. Beets GL, Oosterhuis KJ, Go PM, et al. Longterm followup (12-15 years) of a randomized controlled trial comparing Bassini-Stetten, Shouldice, and high ligation with narrowing of the internal ring for primary inguinal hernia repair. J Am Coll Surg 1997; 185(4):352-7.
36. Usher FC, Ochsner J, Tuttle LL, Jr. Use of marlex mesh in the repair of incisional hernias. Am Surg 1958; 24(12):969-74.
37. Lichtenstein IL, Shulman AG. Ambulatory outpatient hernia surgery. Including a new concept, introducing tension-free repair. Int Surg 1986; 71(1):1-4.
38. Wijsmuller AR, Lange JF, van Geldere D, et al. Surgical techniques preventing chronic pain after Lichtenstein hernia repair: state-of-the-art vs daily practice in the Netherlands. Hernia 2007; 11(2):147-51.
39. Gilbert AI. Overnight hernia repair: updated considerations. South Med J 1987; 80(2):191-5.
40. Robbins AW, Rutkow IM. The mesh-plug hernioplasty. Surg Clin North Am 1993; 73(3):501-12.
41. Stoppa R. Hernia of the abdominal wall. Vol. 155. Berlin Germany: Springer-Verlag, 1987.
42. Wantz GE. [Technique of properitoneal hernioplasty. Unilateral reinforcement of the visceral sac with Mersilene giant prosthesis]. Chirurgie 1993; 119(6-7):321-6.
43. Kugel RD. Minimally invasive, nonlaparoscopic, preperitoneal, and sutureless, inguinal herniorrhaphy. Am J Surg 1999; 178(4):298-302.
44. Ger R, Monroe K, Duvivier R, Mishrick A. Management of indirect inguinal hernias by laparoscopic closure of the neck of the sac. Am J Surg 1990; 159(4):370-3.
45. Filipi CJ, Fitzgibbons RJ, Jr., Salerno GM, Hart RO. Laparoscopic herniorrhaphy. Surg Clin North Am 1992; 72(5):1109-24.
46. Kuhry E, van Veen RN, Langeveld HR, et al. Open or endoscopic total extraperitoneal inguinal hernia repair? A systematic review. Surg Endosc 2007; 21(2):161-6.
47. Edwards CC, 2nd, Bailey RW. Laparoscopic hernia repair: the learning curve. Surg Laparosc Endosc Percutan Tech 2000; 10(3):149-53.

48. Neumayer L, Giobbie-Hurder A, Jonasson O, et al. Open mesh versus laparoscopic mesh repair of inguinal hernia. N Engl J Med 2004; 350(18):1819-27.
49. Group MRCLGHT. Cost-utility analysis of open versus laparoscopic groin hernia repair: results from a multicentre randomized clinical trial. Br J Surg 2001; 88(5):653-61.
50. Kald A, Anderberg B, Smedh K, Karlsson M. Transperitoneal or totally extraperitoneal approach in laparoscopic hernia repair: results of 491 consecutive herniorrhaphies. Surg Laparosc Endosc 1997; 7(2):86-9.
51. Tsang S, Normand R, Karlin R. Small bowel obstruction: a morbid complication after laparoscopic herniorrhaphy. Am Surg 1994; 60(5):332-4.
52. Darzi A, Paraskeva PA, Quereshi A, et al. Laparoscopic herniorrhaphy: initial experience in 126 patients. J Laparoendosc Surg 1994; 4(3):179-83.
53. Phillips EH, Arregui M, Carroll BJ, et al. Incidence of complications following laparoscopic hernioplasty. Surg Endosc 1995; 9(1):16-21.
54. Poobalan AS, Bruce J, Smith WC, et al. A review of chronic pain after inguinal herniorrhaphy. Clin J Pain 2003; 19(1):48-54.
55. Cunningham J, Temple WJ, Mitchell P, et al. Cooperative hernia study. Pain in the postrepair patient. Ann Surg 1996; 224(5):598-602.
56. Poobalan AS, Bruce J, King PM, et al. Chronic pain and quality of life following open inguinal hernia repair. Br J Surg 2001; 88(8):1122-6.
57. Lichtenstein IL, Shulman AG, Amid PK, Montllor MM. Cause and prevention of postherniorrhaphy neuralgia: a proposed protocol for treatment. Am J Surg 1988; 155(6):786-90.
58. Wantz GE. Complications of inguinal hernial repair. Surg Clin North Am 1984; 64(2):287-98.
59. Amid PK. Lichtenstein tension-free hernioplasty: its inception, evolution, and principles. Hernia 2004; 8(1):1-7.
60. Lynch SA, Renstrom PA. Groin injuries in sport: treatment strategies. Sports Med 1999; 28(2):137-44.
61. Slavotinek JP, Verrall GM, Fon GT, Sage MR. Groin pain in footballers: the association between preseason clinical and pubic bone magnetic resonance imaging findings and athlete outcome. Am J Sports Med 2005; 33(6):894-9.
62. Steele P, Annear P, Grove JR, et al. Surgery for posterior inguinal wall deficiency in athletes. J Sci Med Sport 2004; 7(4):415-21; discussion 422-3.
63. Zimmerman G. Groin pain in athletes. Aust Fam Physician 1988; 17(12):1046-52.
64. Lovell G. The diagnosis of chronic groin pain in athletes: a review of 189 cases. Aust J Sci Med Sport 1995; 27(3):76-9.
65. Gilmore J. Groin pain in the soccer athlete: fact, fiction, and treatment. Clin Sports Med 1998; 17(4):787-93.
66. Srinivasan A, Schuricht A. Long-term follow-up of laparoscopic preperitoneal hernia repair in professional athletes. J Laparoendosc Adv Surg Tech A 2002; 12(2):101-6.
67. Fon LJ, Spence RA. Sportsman's hernia. Br J Surg 2000; 87(5):545-52.
68. Akita K, Niga S, Yamato Y, et al. Anatomic basis of chronic groin pain with special reference to sports hernia. Surg Radiol Anat 1999; 21(1):1-5.
69. de Wilt JH, Ijzermans JN, Hop WC, Jeekel J. [The treatment of recurrent inguinal hernia]. Ned Tijdschr Geneeskd 1990; 134(11):531-4.
70. Hay JM, Boudet MJ, Fingerhut A, et al. Shouldice inguinal hernia repair in the male adult: the gold standard? A multicenter controlled trial in 1578 patients. Ann Surg 1995; 222(6):719-27.
71. IJzermans JN, de Wilt H, Hop WC, Jeekel H. Recurrent inguinal hernia treated by classical hernioplasty. Arch Surg 1991; 126(9):1097-100.
72. Janu PG, Sellers KD, Mangiante EC. Mesh inguinal herniorrhaphy: a ten-year review. Am Surg 1997; 63(12):1065-9; discussion 1069-71.

73. Kux M, Fuchsjager N, Schemper M. Shouldice is superior to Bassini inguinal herniorrhaphy. Am J Surg 1994; 168(1):15-8.
74. Paul A, Troidl H, Williams JI, et al. Randomized trial of modified Bassini versus Shouldice inguinal hernia repair. The Cologne Hernia Study Group. Br J Surg 1994; 81(10):1531-4.
75. Scott NW, McCormack K, Graham P, et al. Open mesh versus non-mesh for repair of femoral and inguinal hernia. Cochrane Database Syst Rev 2002(4):CD002197.

Chapter 2

Spinal or Local Anesthesia in Lichtenstein Hernia Repair; a Randomised Controlled Trial

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Chapter
2

Abstract

Background: With established protocols lacking, the choice of anesthetic technique remains arbitrary in inguinal hernia repair. Well-designed studies in this subject are important because of the gap or discrepancy between available scientific evidence and clinical practice.

Methods: Between August 2004 and June 2006, a multi-center prospective clinical trial was performed, in which 100 patients with unilateral primary inguinal hernia were randomized to spinal or local anesthesia. Clinical examination took place within 2 weeks postoperatively and at 3 months in the outpatient clinic.

Results: Analysis of postoperative VAS scores showed that patients operated under local anesthesia had significant less pain shortly after surgery ($p = 0.021$). Significantly more urinary retention ($p < 0.001$) and more overnight admissions ($p = 0.004$) occurred after spinal anesthesia. Total operating time is significantly shorter in the local anesthesia group ($p < 0.001$).

No significant differences were found between the two groups with respect to the activities of daily life, and quality of life.

Conclusion: Our study provides evidence that local anesthesia is superior to spinal anesthesia in inguinal hernia repair. Local anesthesia in primary, inguinal hernia repairs should be the method of choice.

Introduction

Several studies indicate that local infiltration anesthesia for inguinal herniorrhaphy blocks surgical stress effectively, provides extended postoperative analgesia, is simple to execute and safe for high-risk patients. In addition patients are able to mobilise early without postanesthesia side effects.[1-6] A great majority of existing randomized controlled studies, of which only one small trial compares regional with local anesthesia, have shown benefits for local anesthesia and recommend it as the method of choice.[7-12] Nevertheless, complaints of significantly more pain are reported in patients operated under local anesthesia.[13, 14] The surgeon's lack of familiarity with the technique is usually held responsible.[13]

In 2003 evidence-based guidelines for the treatment of inguinal hernia in adults were developed in the Netherlands.[15] The main recommendations of these guidelines were to use a mesh-based repair technique in adult patients as previous studies of our research group also has demonstrated and to consider local anesthesia when performing open anterior repair.[16, 17] Currently only seven per cent of all inguinal hernia repairs performed by general surgeons in the Netherlands are carried out under local anesthesia. Forty per cent of anesthesiologists in the Netherlands prefer to use spinal anesthesia, which may lead to the following adverse effects: headache, urinary retention, motor block of lower extremities, intraoperative hypotension, and delayed mobility resulting in a delayed release from hospital.[18]

With established protocols lacking, the choice of anesthetic technique remains arbitrary. Well designed studies in this subject are important because of the gap or discrepancy between available scientific evidence and clinical practice.

The purpose of this randomised controlled trial was to compare local infiltration anesthesia and spinal anesthesia in the surgical treatment of inguinal hernia.

Method

Between August 2004 and June 2006, 117 patients scheduled for repair of a primary unilateral inguinal hernia according to the method described by Lichtenstein and Amid,[19,20] were eligible for inclusion in this study. Patients could only be enrolled once and were not included if they were aged under 18 years, suffered from a recurrent hernia, femoral hernia, bilateral hernia, were pregnant, had bleeding abnormalities, or were unfit for spinal anaesthesia; as judged by the anesthesiologist. The regional Ethics Committee of each three participating hospital approved the protocol. All patients gave written informed consent before surgery.

Patients were randomly allocated before surgery to receive local or regional anesthesia during hernia repair. The randomisation process was done by use of computer-generated random number sequences and consecutively numbered, sealed, opaque envelopes in blocks of 10, distributed to and stratified by each hospital by the study coordinator.

Primary endpoint was pain during the first week after surgery.

Secondary endpoints were postoperative complications, transfer time between operations by anesthesiologist and surgeon, length of postoperative stay, intervention of anaesthesiologists in patients operated under local anaesthesia and time to return to normal activities.

Before surgery, patient history, American Society of Anesthesiologists physical status (ASA), Body Mass Index (BMI), and transfer time from the pre-operative unit to the operating theatre was recorded.

During surgery, total time of operation, type of hernia, and nerve preservation or division were noted.

After surgery, special attention was paid to urinary retention. Therefore, time till first miction was recorded, urinary retention three hours after surgery was measured, and in case of urinary complains catheterisation was performed. Pain during the procedure was measured retrospectively by a Visual Analogue Scale score (VAS in centimetres).
Duration of hospital stay, unplanned overnight admission, and early complications were also recorded.

All patients were electively operated in day-care surgery.

To assess activities of daily life, patients were asked to keep a diary in which they filled in a Dutch-designed questionnaire.[21] The questionnaire was filled in preoperatively and daily from the same day of operation till day 7. In addition, the patients completed a questionnaire on pain. Average pain (VAS in centimetres) for the first 7 days was scored daily. Finally, health-related quality of life was measured preoperatively and during 7 days postoperatively by the Short Form-36 (SF-36)[22] and the Euroqol-5 dimensional survey (EQ-5D).[23]

Clinical examination took place within 2 weeks postoperatively and at 3 months in the outpatient clinic. Patients were preferably seen by the trial coordinator who was blinded for therapy.

Additionally a specially trained nurse contacted the patients by phone: an interview on complications, time to return to normal level of daily activities and satisfaction rate on a scale from 0 to 10 was taken at three months follow-up.
The operations were performed either by a staff surgeon or by an experienced resident surgeon.

Spinal anaesthesia was performed according to the anaesthesiologists' method of choice, preferably by a L3-4 intervertebral midline approach. The subarachnoid injection

contained a mixture of heavy bupivacaine (0.5%) with sufentanil (5 mcg/ml). The study was designed to mimic clinical reality in general surgery. In order to emphasiza the easy incorporation and superiority of the local infiltration technique, three centers were chosen who preferred spinal anesthesia and had no experience with local infiltration anesthesia. An additional local infiltration block in the spinal anesthesia group was not added to stress out the differences between spinal and local anesthesia.

Local anaesthesia was executed by the surgeon in accordance with the local infiltration technique described by Amid and colleagues.[1] A mixture of maximum 40 ml Lidocain (1%) with Adrenaline (2%) and bupivacain (0.5%) was used. During surgery anesthesia care and sedation were monitored by an anesthesiological nurse. Sedation during surgery was optional for patients who had local anaesthetics. Recommended was a rapifen (1mg) dormicum (5mg) mixture.[24]

Mesh repair was performed according to the technique as described by Lichtenstein and Shulman.[19]

Categorical variables were compared with the Chi-square test, continuous variables were compared with the Mann Whitney U test, and repeated measurements were compared by repeated measurement ANOVA using mixed models, which allowed adjustment for baseline values, gender and age.[25]

Differences between the groups on the dimensions of the SF-36, VAS and EQ-5D were studied both per point in time and for the whole follow-up. Continuous data were displayed as median (minimum-maximum). Differences from the baseline per group were tested for statistical significance using Wilcoxon's signed rank sum test. All analyses were conducted using SPSS (version 11.5, SPSS Inc., Chicago, USA). A P-value <0.05 (two-sided) was considered statistically significant.

Results

Hundred and seventeen patients were randomized. Seventeen patients were excluded, sixteen patients withdrew informed consent before operation and did not want to participate in the trial. One patient was excluded because of a diagnosed femoral hernia. Of the remaining 100 patients, 49 had been randomized to spinal anesthesia and 51 to local anesthesia (Figure 1).

The characteristics of patients at baseline of the spinal and local anesthesia group were not significantly different (Table 1).

Twelve patients (25%) in the spinal anesthesia group reported pain intraoperatively compared to eighteen (35%) patients in the local anesthesia group. (p = 0.167).

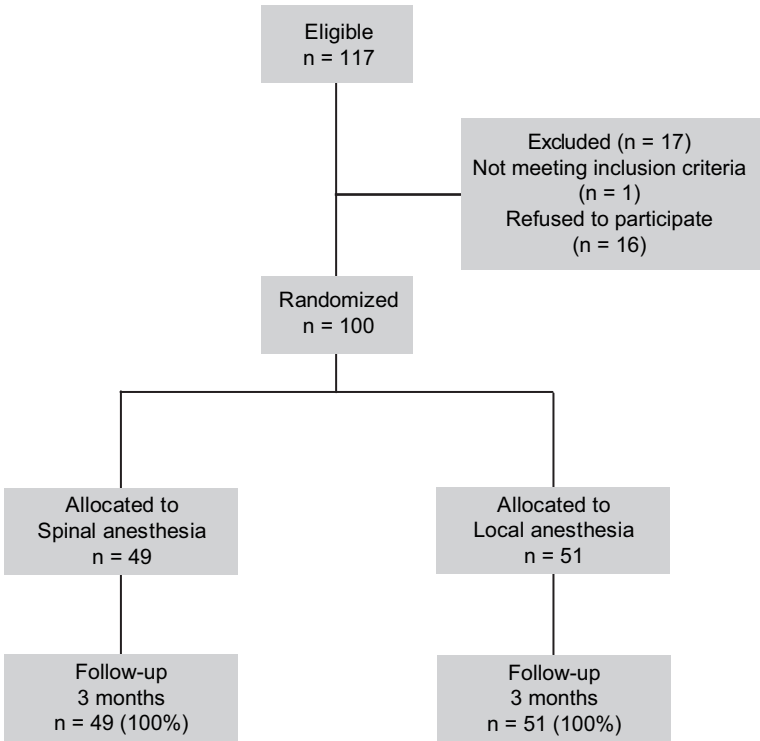

Figure 1. Flow-chart

Table 1. Basic characteristics

	Total (n = 100)			Spinal anesthesia (n = 49)			Local anesthesia (n = 51)		
Men (%)	95	(95%)		47	(96%)		48	(94%)	
Age (years): median (range)	64	(29-88)		65	(36-88)		63	(29-84)	
Body mass index (range)*	25.3	(17.7-37.4)		26.3	(20.8-37.4)		24.5	(17.7-31.1)	
Chronic Obstructive Pulmonary Disease (%)	11	(11)		7	(14)		4	(8)	
ASA (I, II, III)	53	22	25	23	12	14	30	10	11

* The body mass index was calculated as the weight in kilograms divided by the square of height in meters

** Devision of 1 or more inguinal nerves

Analysis of total postoperative VAS measurements, did not show a significant difference in pain between both groups. Analysis of the separate assessment times however, resulted in a difference in pain shortly after surgery (time point 1, p = 0.021), with significantly more pain after spinal anesthesia compared with local anesthesia (Figure 2).

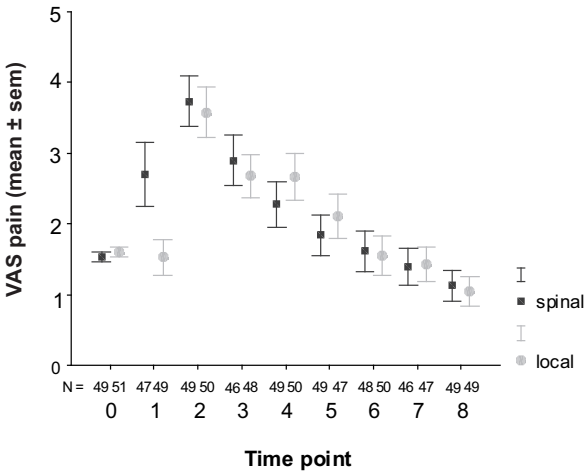

Figure 2. Visual Analogue Scale (VAS) score

Vas pain score in standard error of the mean.
Time point 0 is before surgery. Time points 1 is 3 hours after surgery. Time points 2 till 8 represents day 1 till day 7 after surgery.

Although all patients were planned in day-care surgery, significantly more overnight admissions occurred after spinal anesthesia compared with local anesthesia (Table 2) ($p = 0.004$). The main reason of overnight admissions was urinary retention. Both in the spinal as local anesthesia group two patients were operated late in the afternoon and were discharged the next day. Significantly more urinary retention and catheterization occurred after spinal anesthesia (Table 3) ($p < 0.001$).

Table 2. Overnight admissions

	Spinal anesthesia n = 49		Local anesthesia n = 51		P-value
Overnight admissions*	12	(24%)	2	(4%)	0.004

*All patients planned in day-care surgery

Total operating time was significantly shorter in the local anesthesia group ($p < 0.001$), because the transfer time between operations was shorter. (Table 4) Interventions of anesthesiologists were not necessary during operations in both the spinal and local anesthesia group.

No significant differences were found for the separate items of activities of daily life at any of the assessment days. The same applied to the changes from baseline. Only SF36

dimension 'role physical' was significantly different in favour of spinal anesthesia (22.5 points; p = 0.007, 95% CI: 6.3 to 38.7).

Table 3. Urinary retention

	Spinal anesthesia n = 49		Local anesthesia n = 51		P value
Longer than 3 hours after surgery*	37	(76%)	10	(20%)	< 0.001
Urinary catheterization	13	(27%)	0	(0%)	< 0.001

* Urinary retention after bladder scan

Table 4. Operation time

	Total (n = 100)		Spinal anesthesia (n = 49)		Local anesthesia (n = 51)		P value
Total time (minutes): median (range)	51	(25-90)	57	(35-90)	45	(25-90)	p < 0.001
Transfer time (minutes): median (range)*	15	(5-40)	21	(10-40)	10	(5-30)	p < 0.001
Operation time (minutes): median (range)**	39	(20-90)	40	(25-90)	37	(20-80)	p = 0.432

* Duration of preoperative work-up by anesthesiologist (spinal anesthesia) or surgeon (local anesthesia)
** Duration of first incision till closure of the skin

Table 5: Follow-up

	Spinal anesthesia (n = 49)			Local anesthesia (n = 51)		
Hematoma (%)*	6	(12)		8	(16)	
Wound infection*	2	(4)		3	(6)	
Reintervention*	0	(0)		0	(0)	
Numbness*	15	(31)		15	(29)	
Normal daily activities*	30	(61)		47	(92)	
Preservation (%), devision (%)**	80	20		74	26	
Hernia type: medial, lateral, pantaloon	32	15	2	28	20	3

* Within 3 months follow-up
** Devision of 1 or more inguinal nerves

No significant correlation was found between the spinal and local anesthesia group with respect to hematomas (p = 0.419), wound infections (p = 0.519), and numbness (p = 0.534) within three months follow-up. Nineteen patients in the spinal anesthesia group

did not receive their old level of normal activities within three months, compared to four patients in the local anesthesia group (Table 5) ($p < 0.001$).

Satisfaction grade on a scale from 0 to 10 showed a mean of 7.3 in the spinal anesthesia group, and 7.8 in the local anesthesia group which is not significantly different.

Discussion

Groin hernia repair is the most common procedure performed in general surgery. It is remarkable that a consensus concerning the type of anesthesia is still lacking in The Netherlands.

Current data reflect a large variation in anesthetic practice, which appears to be based on surgeon and anesthesiologist preferences.[26] Large epidemiologic studies from Scotland,[27] Sweden,[28] and Denmark,[5] have shown that spinal anesthesia for hernia repair is used in 10% to 20% of the cases, and local infiltration anesthesia in about 10%. In the Netherlands 7% of all herniorrhaphies are carried out under local anesthesia and 40% under spinal anesthesia.[18] This is surprising, as there are no documented benefits of spinal anesthesia.[29] More importantly, this anesthetic technique has been demonstrated to have the highest risk of urinary retention, with rates up to 20-27% in our study and other studies.[6,8,30] Because of the high incidence of urinary retention, overnight admissions occur significantly more after spinal anesthesia.

Also, spinal anesthesia requires preoperative and preoperative assessment by the anaesthesiologist. Unlike our study, several series have reported the need to add general anesthesia in about 5% to 10% of patients during spinal anesthesia because of insufficient intraoperative pain relief.[30,31]

Inguinal hernia repair under local anesthesia leads to significantly less pain within three hours after surgery. Early postoperative pain is reduced when local infiltration anesthesia is used. It is documented that long-acting local anesthetics like bupivacain last for 4 to 6 hours which is significantly longer compared with spinal analgesia.[2] The difference in VAS score shortly after surgery compared with day one after surgery is remarkable (Figure 2). Correct use of analgesics will possibly reduce pain during the first postoperative week.

No significant differences exists between both groups ($p = 0.167$) with respect to pain intraoperatively. These retrospective pain measurements are not a reliable indicator of intraoperative pain of inguinal hernia repair, because it includes both inguinal hernia repair and infiltration of either spinal or local anesthesia performed in the preoperative care unit.

Our study provides evidence that local anesthesia is superior to spinal anesthesia in inguinal hernia repair performed by general surgeons. Local anesthesia provides benefits for the patients in terms of highly satisfactory intraoperative analgesia, faster recovery, less postoperative pain, no urinary retention (versus 27% after spinal anesthesia), faster mobilization and higher satisfaction throughout the first three months. Benefits for the hospital are: significantly shorter total operating time, operation executed without interference of an anesthesiologists, and a reduced length of hospital stay. Furthermore, incorporation of local infiltration anesthesia technique by general surgeons is easy.

In conclusion, local anesthesia in primary, inguinal hernia repairs should be considered as a method of choice.

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References

1. Amid PK, Shulman AG, Lichtenstein IL. Local anesthesia for inguinal hernia repair step-by-step procedure. Ann Surg 1994; 220(6):735-7.
2. Callesen T, Bech K, Kehlet H. The feasibility, safety and cost of infiltration anaesthesia for hernia repair. Hvidovre Hospital Hernia Group. Anaesthesia 1998; 53(1):31-5.
3. Tverskoy M, Cozacov C, Ayache M, et al. Postoperative pain after inguinal herniorrhaphy with different types of anesthesia. Anesth Analg 1990; 70(1):29-35.
4. Kark AE, Kurzer MN, Belsham PA. Three thousand one hundred seventy-five primary inguinal hernia repairs: advantages of ambulatory open mesh repair using local anesthesia. J Am Coll Surg 1998; 186(4):447-55; discussion 456.
5. Bay-Nielsen M, Kehlet H, Strand L, et al. Quality assessment of 26,304 herniorrhaphies in Denmark: a prospective nationwide study. Lancet 2001; 358(9288):1124-8.
6. Ozgun H, Kurt MN, Kurt I, Cevikel MH. Comparison of local, spinal, and general anaesthesia for inguinal herniorrhaphy. Eur J Surg 2002; 168(8-9):455-9.
7. O'Dwyer PJ, Serpell MG, Millar K, et al. Local or general anesthesia for open hernia repair: a randomized trial. Ann Surg 2003; 237(4):574-9.
8. Nordin P, Zetterstrom H, Gunnarsson U, Nilsson E. Local, regional, or general anaesthesia in groin hernia repair: multicentre randomised trial. Lancet 2003; 362(9387):853-8.
9. Song D, Greilich NB, White PF, et al. Recovery profiles and costs of anesthesia for outpatient unilateral inguinal herniorrhaphy. Anesth Analg 2000; 91(4):876-81.
10. Gonullu NN, Cubukcu A, Alponat A. Comparison of local and general anesthesia in tension-free (Lichtenstein) hernioplasty: a prospective randomized trial. Hernia 2002; 6(1):29-32.
11. Gultekin FA, Kurukahvecioglu O, Karamercan A, et al. A prospective comparison of local and spinal anesthesia for inguinal hernia repair. Hernia 2007; 11(2):153-6.
12. Friemert B, Faoual J, Holldobler G, et al. [A prospective randomized study on inguinal hernia repair according to the Shouldice technique. Benefits of local anesthesia]. Chirurg 2000; 71(1):52-7.
13. Callesen T, Bech K, Kehlet H. One-thousand consecutive inguinal hernia repairs under unmonitored local anesthesia. Anesth Analg 2001; 93(6):1373-6, table of contents.
14. Teasdale C, McCrum AM, Williams NB, Horton RE. A randomised controlled trial to compare local with general anaesthesia for short-stay inguinal hernia repair. Ann R Coll Surg Engl 1982; 64(4):238-42.
15. Simons MP, de Lange D, Beets GL, et al. [The 'Inguinal Hernia' guideline of the Association of Surgeons of the Netherlands]. Ned Tijdschr Geneeskd 2003; 147(43):2111-7.
16. Vrijland WW, van den Tol MP, Luijendijk RW, et al. Randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia. Br J Surg 2002; 89(3):293-7.
17. van Veen RN, Vrijland WW, Wijsmuller AR, et al. Long-term follow-up of a randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia Br J Surg 2007:Article accepted for publication.
18. de Lange DH, Aufenacker TJ, Roest M, et al. Inguinal hernia surgery in The Netherlands: a baseline study before the introduction of the Dutch Guidelines. Hernia 2005; 9(2):172-7.
19. Lichtenstein IL, Shulman AG, Amid PK, Montllor MM. The tension-free hernioplasty. Am J Surg 1989; 157(2):188-93.
20. Amid PK. Lichtenstein tension-free hernioplasty: its inception, evolution, and principles. Hernia 2004; 8(1):1-7.
21. Picavet HSJ vSJ, van den Bos GAM. Health Interview Surveys. Mndber Gezondheid (CBS) 1992; 7:5-20.

22. Ware JE, Jr., Gandek B. Overview of the SF-36 Health Survey and the International Quality of Life Assessment (IQOLA) Project. J Clin Epidemiol 1998; 51(11):903-12.
23. Brooks R. EuroQol: the current state of play. Health Policy 1996; 37(1):53-72.
24. www.CBO.nl. Assessed January 12, 2007.
25. Aaronson NK, Muller M, Cohen PD, et al. Translation, validation, and norming of the Dutch language version of the SF-36 Health Survey in community and chronic disease populations. J Clin Epidemiol 1998; 51(11):1055-68.
26. Kehlet H, Aasvang E. Groin hernia repair: anesthesia. World J Surg 2005; 29(8):1058-61.
27. Hair A, Duffy K, McLean J, et al. Groin hernia repair in Scotland. Br J Surg 2000; 87(12):1722-6.
28. Nordin P, Haapaniemi S, van der Linden W, Nilsson E. Choice of anesthesia and risk of reoperation for recurrence in groin hernia repair. Ann Surg 2004; 240(1):187-92.
29. Moen V, Dahlgren N, Irestedt L. Severe neurological complications after central neuraxial blockades in Sweden 1990-1999. Anesthesiology 2004; 101(4):950-9.
30. Jensen P, Mikkelsen T, Kehlet H. Postherniorrhaphy urinary retention--effect of local, regional, and general anesthesia: a review. Reg Anesth Pain Med 2002; 27(6):612-7.
31. Mulroy MF, Burgess FW, Emanuelsson BM. Ropivacaine 0.25% and 0.5%, but not 0.125%, provide effective wound infiltration analgesia after outpatient hernia repair, but with sustained plasma drug levels. Reg Anesth Pain Med 1999; 24(2):136-41.

Chapter 3

Nerve-Management During Open Herniorraphy

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Abstract

Background: Peroperative identification and subsequent division or preservation of the inguinal nerves during open hernia repair may influence the incidence of chronic postoperative pain.

Methods: A systematic literature review was performed to identify studies investigating the influence of different types of nerve management.

Results: Based on three randomized studies the pooled mean per centage of patients with chronic pain after identification and division of the ilioinguinal nerve was similar to that after identification and preservation of the ilioinguinal nerve. Two cohort studies suggested that the incidence of chronic pain was significantly lower after identification of all inguinal nerves compared with no identification of any nerve. Another cohort study reported a significant difference in the incidence of chronic pain in favour of identification and facultative pragmatic division of the genital branch of the genitofemoral nerve compared with no identification at all.

Conclusion: The nerves should probably be identified during open hernia repair. Division of and preservation of the ilioinguinal nerve show similar results.

Introduction

A review by Poobalan et al.[1] of studies of inguinal hernia repair between 1987 and 2000 showed the incidence of chronic postoperative pain to be up to 53 per cent (range 0-53), making it the most frequent complication after surgery. The commonest types of chronic postoperative pain are somatic and neuropathic.[2-4]

Causalgia syndromes affecting all three inguinal nerves (ilioinguinal and iliohypogastric nerves and genital branch of genitofemoral nerve) have been described.

There is no concesus on whether or not to identify and subsequently divide or preserve these three nerves together, or separately, during surgery.[5] Lichtenstein and his successor Amid[6,7] recommend preservation of all three nerves, whereas Wantz[8] recommends intentional severance based on the concept of 'no nerve, no pain. This review evaluates the influence of peroperative inguinal nerve identification and subsequent division or preservation on the incidence of chronic postoperative pain.

Materials and methods

Studies on the effect of peroperative inguinal nerve identification and subsequent division or preservation were included if they contained data on pain lasting longer than 3 months after operation.[9] Randomized, prospective and retrospective cohort studies were included. Reviews and references of the articles retrieved were checked for additional studies. Letters to the editor, abstracts and comments were excluded. English, German and French articles were reviewed.

Studies were identified by searching Pubmed, The Cochrane Library (Issue 1, 2006), scholar.google.com and Current Controlled Trials (search across multiple registers including the NHS in England and US ClinicalTrials.gov). Search terms used and crosschecked were 'pain, postoperative', 'pain, chronic', 'hernia, inguinal', 'denervation' and 'neurectomy'.

Data were extracted by two authors (A.R.W, R.N.v.V.) independently. Study quality was assessed according to a number of variables, such as the quality of methodological reporting, whether studies were randomized, non-randomized, prospective or retrospective, method of randomization and allocation concealment, blinding of outcome assessors, attempts made to minimize bias, sample sizes and ability to measure "true effect". Levels of evidence were assessed according to the Oxford Centre for Evidece Based Medicine levels of evidence.[10,11] Discrepancies were resolved by consensus. The following data were abstracted: type of study, number of patients, baseline characteristics, type of repair, peroperative nerve treatment, follow-up period, incidence of chronic pain and type of assessment.

From the data provided in the individual studies, the pooled means for chronic pain after hernia repair and their 95% confidence intervals were calculated using the random-effects model described by Laird and Mosteller.[12] A pooled mean per centage of patients with chronic pain at 6 months after operation was calculated from three randomized clinical trials investigating the influence of ilioinguinal nerve preservation or division.[13-15]

Results

Thirteen articles on the influence of inguinal nerve management were identified, of which one letter to the editor, one editorial and one comment were excluded.[16-18] Two studies that investigated the influence of iliohypogastric and ilioinguinal nerve division in one group were excluded as there were no comparable groups in which these nerves were preserved.[19, 20] Another study investigating the influence of ilioinguinal division compared to preservation was excluded as not all the required data were reported.[21] This left seven studies for analysis, including three randomized trials and four cohort studies (of retrospective and prospective character) (Table 1).[13-15, 22-25]

Of these studies seven studies, four investigated the influence of ilioinguinal nerve division compared with ilioinguinal nerve preservation,[13-15,22] including the three randomized trials. In addition, two other studies compared the influence of no inguinal nerve identification with identification & preservation of all inguinal nerves.[23,24] Finally, one study compared the influence of no identification with identification and subsequent pragmatic facultative division of the genital branch of the genitofemoral nerve.[25]

Table 2 shows the baseline characteristics of patients included in this review by study and by treatment group. Most of the characteristics were not significantly different between treatment groups. A significant difference was, however, present in the proportion of patients with a combined or direct inguinal hernia in the study by Tons and Schumpelick[25] (Table 2).

Table 1: Characteristics of studie

Study	Type	Study location	No. of Institutions/ Surgeons	Study period	Surgical technique	Level of evidence*
Ilioinguinal nerve division *versus* preservation						
Ravichandran et al.[13]	RCT double-blind pilot	UK	1/ 1	NR	Tension-free mesh repair	2b
Picchio et al.[14]	RCT double-blind	Italy	4/ NR	1997-2002	Trabucco	1b
Mui et al.[15]	RCT double-blind	China	1/ 4	2003-2004	Lichtenstein repair	1b
Dittrick et al.[22]	Cohort retrospective	USA	NR/ 2†	1997-2003	Lichtenstein repair	2b
No identification of any nerve *versus* identification and preservation of all nerves						
Izard et al.[23]	Cohort prospective	France	1/ 1	1979-1992	Mc Vay	2b
Alfieri et al.[24]‡	Cohort prospective	Italy	11/ NR	2002-2003	Lichtenstein or Trabucco	2b
No identification of genital branch *versus* identification and facultative pragmatic division of genital branch§						
Tons and Schumpelick[25]	Cohort prospective	Germany	1/ NR	1985-1988	Shouldice	2b

* Oxford-Centre for Evidence Based Medicine (http://www.cebm.net/levels_of_evidence.asp). † Two surgeons of whom one routinely divided and one routinely preserved the ilioinguinal nerve. ‡ Groups included in this analysis are part of a broader prospective cohort study by Alfieri et al. In group I (n = 380) all nerves were identified with the following subgroups: subgroup A, all nerves preserved (n = 310); subgroup B, all nerves divided (n = 10); and subgroup C, one or two nerves injured/divided (n = 60). In group II no nerves were identified (n = 189). Group III (n = 404) consisted of two subgroups: subgroup D, one nerve was not identified (n = 260); and subgroup E, two nerves were not identified (n = 144). § Genital branch of the genitofemoral nerve was divided in 24 per cent. RCT, randomized clinical trial; NR, not reported.

Table 2

Study	No. of Pts	Male (%)	Mean Age (Y)	Hernia type (%)				Preoperative pain (%)	No ilioinguinal nerve identified (%)
				Indirect	Direct	Combined	Other		
Ilioinguinal nerve identification and division									
Ravichandran et al.[13]	20*	100	65*	NR	NR	NR	NR	NR	0
Picchio et al.[14]	405	92	57	68	30	3	0	55†	10
Mui et al.[15]	50	100	65	NR	NR	NR	NR	10‡	0
Dittrick et al.[22]	66	77	68	NR	NR	NR	NR	NR	0
Ilioinguinal nerve identification and preservation									
Ravichandran et al.[13]	20*	100	65*	NR	NR	NR	NR	NR	20
Picchio et al.[14]	408	89	59	66	30	4	0	49†	13
Mui et al.[15]	50	100	63	NR	NR	NR	NR	14‡	0
Dittrick et al.[22]	24	79	58	NR	NR	NR	NR	NR	0
No identification of any nerve									
Izard et al.[23]	441	NR	NR§	64#	21#	5#	9#	NR	NA
Alfieri et al.[24]§	189	97¶	55¶	NR**	NR**	NR**	NR**	NR**	NA
Identification and preservation of all inguinal nerves									
Izard et al.[23]	891	NR	NR§	67#	17#	6#	10#	NR	NA
Alfieri et al.[24]§	310	97¶	55¶	NR**	NR**	NR**	NR**	NR**	NA
No identification genital branch									
Tons and Schumpelick[25]	237	100	NR	52	18	30	0	NR	NA
Identification and facultative pragmatic division genital branch									
Tons and Schumpelick[25]	223	100	NR	51	28	21	0	NR	NA

* The procedures were performed in one group of 20 patients with bilateral hernia and a mean age of 65.2 years. The ilioinguinal nerve was divided on one side and preserved on the other side, determined by randomization. † Pre-operative pain (no significant difference). ‡ At least mild pain pre-operatively at rest on a four-point verbal scale: 0, none; 1, mild; 2, moderate; and 3, severe (no significant difference, p = 0.54). § An age distribution was given for the whole group. # Hernia type distribution among patients with follow-up greater than 5 years (911 patients in total). ¶ Mean per centage of men and the mean age of the total study group. ** Type of hernia and type of repair were recorded for the total group. No correlation was found between moderate to severe pain and type of hernia or repair technique used (p = 0.67 and p = 0.2, respectively). NR, not reported; NA, not applicable

All four studies investigating the influence of ilioinguinal nerve division or preservation reported the incidence of chronic pain at 6 months after surgery. The three randomised studies, on which the calculated pooled mean per centage of patients with chrnonic pain was based, reported results of 851 procedures (428 with ilioinguinal division and 423 after ilioinguinal nerve preservation) (Table 3).

Table 3. Pain after ilioinguinal nerve division or preservation

Study	No. 0f Patients	Pain at 6 months (%)
Ilioinguinal nerve identification and division		
RCT		
Ravichandran et al.[13]	20	5†
Picchio et al.[14]	358	34‡
Mui et al.[15]	50	8§
Mean*		21 (0,43) #
Cohort		
Dittrick et al.[22]	65	3¶
Ilioinguinal nerve identification and preservation		
RCT		
Ravichandran et al.[13]	20	5†
Picchio et al.[14]	354	37‡
Mui et al.[15]	50	29§
Mean*		23 (0,47)#
Cohort		
Dittrick et al.[22]	23	26¶

* Mean based on random-effects model. Values in parentheses are 95 per cent confidence intervals. † Minor wound discomfort (no statistically significant difference). ‡ At least mild pain on a four-point verbal scale: 0, none; 1, mild; 2, moderate; and 3, severe (no statistically significant difference). §Incidence of at least mild pain on exertion (statistically significant difference ($p = 0.008$). # No statistically significant difference between pooled means of the group in which the ilioinguinal nerve was identified and the group in which the ilioinguinal nerve was preserved. ¶ Endpoint was presence of neuralgie (statistically significant differente, $p < 0.001$). RCT, randomized clinical trial

No significant difference was found in the pooled mean per centage of patients with chronic pain after identification and subsequent division of the ilioinguinal nerve (21; 95% CI: 0 to 43) or identification and subsequent preservation of the ilioinguinal nerve (23; 95% CI: 0 to 47) (Table 3). Both studies in which the influence of identification and preservation of all nerves was compared with no identification at all, reported a significant difference in chronic postoperative pain in favour of identification (Table 4).[23,25]

Table 4. Pain after no identification of any nerve or identification and preservation of all nerves

Study	No. of Patients	Pain(%)*
No identification of any nerve		
Izard et al.[23]	297	3.7†
Alfieri et al.[24]	189	4.7‡
Identification all nerves and preservation		
Izard et al.[23]	614	1.6†
Alfieri et al.[24]	310	0.0‡

* The study by Alfieri et al. examined pain at 6 months after surgery, whereas the follow-up by Izard et al was greater than 5 years. † At least major symptoms (discomfort on effort) and persistent and disabling symptoms on a four-point scale: 1, no pain; 2, minor symptoms (often minimal and transient); 3, major symptoms (discomfort on effort); and 4, persistent or disabling symptoms. The difference was statistically significant ($p < 0.001$). ‡ Moderate to severe pain based on a four-point verbal rank scale; none, mild, moderate or severe. The difference was statistically significant.

Tons and Schumpelick recorded persistent pain after a mean (range) of 16.4 (12-25) months in one group of 237 patients in whom the genital branch of the genitofemoral nerve was not identified and in a group of 223 in whom the genital branch was identified and divided facultatively on a pragmatic basis (n = 223). This cohort study showed a significant difference in the per centage of patients with chronic pain, determined by two independent researchers and including three neurological tests and a nerve block to determine the neuropathic character of the problem, in favour of the group in which the genital branch was identified and pragmatically divided (4,2 % versus 1,4 %; $p < 0,05$).

Discussion

Chronic pain may be somatic, neuropatic or visceral in origin. Cunningham et al.[3] reported that the commonest type of chronic pain after surgery was of somatic origin, whereas Poobalan and colleagues[2] and Kehlet and co-workers[4] believe it to be predominatly neuropathic in character. Neurectomy and mesh or staple removal as a treatment for chronic pain after hernia repair has yielded variable results.[26]

The present study has shown that the incidence of chronic pain is significantly less after identification of all three inguinal nerves than after no identification at all in both of two cohort studies[23,24] (Table 4). No pooled mean was calculated from these studies as the type of operation differed between them (McVay, Lichtenstein hernia repair, and Trabucco's technique). Studies investigating the influence of division and preservation of the ilioinguinal nerves are conflicting. Two randomized studies found no significant

difference with respect to the incidence of chronic pain,[13,14] but a further randomized trial and one retrospective cohort study suggested a significant difference in favour of division.[15,17]

A pooled mean per centage of patients with chronic pain was calculated on the basis of the three randomized trials as reported pain was similar for severity and time, although the pain scales used were different: at least minor wound discomfort,[13] at least mild pain on a four-point verbal scale (none, mild, moderate or severe),[14] or incidence of at least mild pain on exertion (mild or severe pain).[15] As all studies determined pain at 6 months after operation, this point in time was used for comparison. The pooled mean did not show any significant difference between the two treatment groups (Table 3). Because of the heterogeneity the pooled results should be interpreted with caution, but a random-effects model was used to take this variation between studies into account.

Pain assessments in the three studies was limited with respect to the following factors that were not recorded: current pain medication, nerve blocks to determine the neuropathic character, quantitative sensory testing thresholds. However, light touch and pain sensitivity were assessed by an observer in the studies by Picchio et al.[14] and Ravichandran et al.[13] Mui et al.[15] assessed skin sensitivity by Semmes-Weinstein monofilament testing. In two studies the level of preoperative pain was included as a baseline patient characteristic and did not show a significant difference between the groups[14,15] (Table 2). No pain scores or questionnaires were included from which postoperative pain might be differentiated as of somatic, neuropathic or visceral origin. Kehlet et al.[27] have proposed a scheme for uniform assessement of chronic postoperative pain (including the factors mentioned above) that should provide a more exact description of the incidence, the type and the socioeconomic consequences of chronic pain state.

As appropriate data have not been reported, this review could not assess the incidence of numbness after nerve division and problems deriving from the division of the motor part of the genital branch of the genitofemoral nerve. Tons and Schumpelick[25] reported the cremaster reflex to be absent in all patients after division of the genital branch, and to be absent after no identification and identification of the genital branch in 51 and 54 per cent of patients respectively. Clinical implications of an absent cremaster reflex are unclear.

With respect to handling of injured nerves, only expert opinion has been published. According to Schumpelick,[28] injured nerves should be divided as proximal as possible. In studies investigating neurectomy as a treatment for postoperative chronic pain, the inguinal nerves under investigation were resected as far proximally as possible.[29-31] Amid[31] resected the three nerves as far proximally and distally as possible, to include the involved segment and account for the numerous neural communications that exists between the three inguinal nerves. Types of proximal nerve-end treatment after division

include crushing, ligation by non-absorbable suture to close the neurilemmal sheath, coagulation, application of either absolute or 12% phenol solution to the nerve end to prevent neuroma formation. One way to prevent nerve scarring in the operative field is to resect the nerve under tension so that it retracts behind the peritoneum; another is to implant the ligated proximal end of the ilioinguinal and iliohypogastric nerves within the fibers of the internal oblique muscle to prevent the ends from adhering to the internal oblique muscle to prevent the ends from adhering to the inguinal ligament and/or external oblique aponeurosis.[30,31] These different types of treatment have been investigated in situations of therapeutical neurectomy after inguinal nerve entrapment but not during primary hernia repair.[29-31]

In conclusion, the available data suggest that the inguinal nerves should be identified during open repair of hernia (grade of recommendation B).[10,11,32] In terms of outcome, there is little difference between dividing or preserving the ilioinguinal nerve (grade of recommendation A). Pragmatic division of the genital branch of the genitofemoral nerve seems beneficial (grade of recommendation C).

References

1. Poobalan AS, Bruce J, Smith WC, et al. A review of chronic pain after inguinal herniorrhaphy. Clin J Pain 2003; 19(1):48-54.
2. Poobalan AS, Bruce J, King PM, et al. Chronic pain and quality of life following open inguinal hernia repair. Br J Surg 2001; 88(8):1122-6.
3. Cunningham J, Temple WJ, Mitchell P, et al. Cooperative hernia study. Pain in the postrepair patient. Ann Surg 1996; 224(5):598-602.
4. Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: risk factors and prevention. Lancet 2006; 367(9522):1618-25.
5. Amid PK, Bendavid, R., Fitzgibbons jr., R.J., McKernan, J.B., Murphy, J.W. . Surgery Roundtable: Current Issues in Inguinal Herniorraphy. 2000.
6. Lichtenstein IL, Shulman AG, Amid PK, Montllor MM. Cause and prevention of postherniorrhaphy neuralgia: a proposed protocol for treatment. Am J Surg 1988; 155(6):786-90.
7. Amid PK. Lichtenstein tension-free hernioplasty: its inception, evolution, and principles. Hernia 2004; 8(1):1-7.
8. Wantz GE. Complications of inguinal hernial repair. Surg Clin North Am 1984; 64(2):287-98.
9. Classification of chronic pain. Descriptions of chronic pain syndromes and definitions of pain terms. Prepared by the International Association for the Study of Pain, Subcommittee on Taxonomy. Pain Suppl 1986; 3:S1-226.
10. Oxford-Centre for Evidence Based Medicine. (http://www.cebm.net/levels_of_evidence.asp, last checked 23/07/06) 2006.
11. Sackett DL. Rules of evidence and clinical recommendations on the use of antithrombotic agents. Chest 1986; 89(2 Suppl):2S-3S.
12. Laird NM, Mosteller F. Some statistical methods for combining experimental results. Int J Technol Assess Health Care 1990; 6(1):5-30.
13. Ravichandran D, Kalambe BG, Pain JA. Pilot randomized controlled study of preservation or division of ilioinguinal nerve in open mesh repair of inguinal hernia. Br J Surg 2000; 87(9):1166-7.
14. Picchio M, Palimento D, Attanasio U, et al. Randomized controlled trial of preservation or elective division of ilioinguinal nerve on open inguinal hernia repair with polypropylene mesh. Arch Surg 2004; 139(7):755-8.
15. Lik-Man Mui W, Ng CS, Ming-Kit Fung T, et al. Prophylactic Ilioinguinal Neurectomy in Open Inguinal Hernia Repair: A Double-Blind Randomized Controlled Trial. Ann Surg 2006; 244(1):27-33.
16. Alfieri S, Di Miceli D, Doglietto GB. Letter 2: Randomized clinical trial assessing impact of a lightweight or heavyweight mesh on chronic pain after inguinal hernia repair (Br J Surg 2005; 92: 166-170). Br J Surg 2005; 92(5):655; author reply 655.
17. Pappalardo G. Pain and functional impairement 1 year after inguinal herniorraphy. Ann Surg 2002; 235(2):311.
18. Condon RE. Groin pain after hernia repair. Ann Surg 2001; 233(1):8.
19. Pappalardo G, Guadalaxara A, Illomei G, et al. Prevention of postherniorrhaphy persistent pain: results of a prospective study. Int Surg 1999; 84(4):350-3.
20. Tsakayannis DE, Kiriakopoulos AC, Linos DA. Elective neurectomy during open, “tension free” inguinal hernia repair. Hernia 2004; 8(1):67-9.
21. Wantz GE. Testicular atrophy and chronic residual neuralgia as risks of inguinal hernioplasty. Surg Clin North Am 1993; 73(3):571-81.

22. Dittrick GW, Ridl K, Kuhn JA, McCarty TM. Routine ilioinguinal nerve excision in inguinal hernia repairs. Am J Surg 2004; 188(6):736-40.
23. Izard G, Gailleton R, Randrianasolo S, Houry R. [Treatment of inguinal hernias by Mc Vay's technique. Apropos of 1332 cases]. Ann Chir 1996; 50(9):755-66.
24. Alfieri S, Rotondi F, Di Giorgio A, et al. Influence of Preservation Versus Division of Ilioinguinal, Iliohypogastric, and Genital Nerves During Open Mesh Herniorrhaphy: Prospective Multicentric Study of Chronic Pain. Ann Surg 2006; 243(4):553-558.
25. Tons C, Kupczyk-Joeris D, Pleye J, et al. [Cremaster resection in Shouldice repair. A prospective controlled bicenter study]. Chirurg 1990; 61(2):109-11.
26. Aasvang E, Kehlet H. Surgical management of chronic pain after inguinal hernia repair. Br J Surg 2005; 92(7):795-801.
27. Kehlet H, Bay-Nielsen M, Kingsnorth A. Chronic postherniorrhaphy pain--a call for uniform assessment. Hernia 2002; 6(4):178-81.
28. Schumpelick V. Durchtrennung des N.ilioinguinalis bei der Leistenbreuchoperation. Chir Praxis 1989; 40:465-466.
29. Madura JA, Madura JA, 2nd, Copper CM, Worth RM. Inguinal neurectomy for inguinal nerve entrapment: an experience with 100 patients. Am J Surg 2005; 189(3):283-7.
30. Ducic I, Dellon AL. Testicular pain after inguinal hernia repair: an approach to resection of the genital branch of genitofemoral nerve. J Am Coll Surg 2004; 198(2):181-4.
31. Amid PK. A 1-stage surgical treatment for postherniorrhaphy neuropathic pain: triple neurectomy and proximal end implantation without mobilization of the cord. Arch Surg 2002; 137(1):100-4.
32. Wijsmuller AR, Lange JF, Kleinrensink GJ, et al. Nerve-identifying inguinal hernia repair: a surgical anatomical study. World J Surg 2007; 31(2):414-20; discussion 421-2.

Chapter 4

Randomized Clinical Trial of Mesh versus Non-Mesh Primary Inguinal Hernia Repair: Long-Term Chronic Pain at 10 years

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Abstract

Background: Prospective studies and meta-analyses have indicated that non-mesh repair is inferior to mesh repair based on recurrence rates in inguinal hernia. The only reliable way to evaluate recurrence rates after hernia surgery is by long-term follow-up.

Methods: Between September 1993 and January 1996, a multicentre clinical trial was performed, in which 300 patients with unilateral primary inguinal hernia were randomized to non-mesh or mesh repair. Long-term follow-up was carried out from June 2005 to January 2006.

Results: Median follow-up was 128 months for non-mesh and 129 months for mesh repair. The 10-year cumulative hernia recurrence rates were 17 and 1 per cent respectively (p = 0•005). Half of the recurrences developed after 3 years' follow-up. There was no significant correlation between hernia recurrence and age, level of expertise of the surgeon, contralateral hernia, obesity, history of pulmonary disease, constipation or prostate disease.

Conclusion: After 10 years mesh repair is still superior to non-mesh hernia repair. Recurrence rates may be underestimated as recurrences continue to develop for up to 10 years after surgery.

Introduction

The use of prosthetic mesh allows tension-free inguinal hernia repair and has proven to result in less recurrences. Concomitant with popularisation of this repair, it has become clear that morbidity associated with this operation mainly consists of chronic groin pain. Long-term randomized studies with 5-year follow-up to investigate chronic groin pain after open mesh versus non-mesh hernia repair have not been published. To determine influence of the introduction of mesh material on the incidence of chronic pain, we conducted a randomized double-blind study of open non-mesh versus mesh hernia repair. In 2002 the long-term results up to 3 years of follow-up were published, which indicated mesh repair to be comparable to non-mesh repair with respect to chronic postoperative pain at 1, 6, 12, 18, 24 and 36 months.[1] The purpose of this paper is to provide results at 10 years of follow-up.

Patients and methods

Between September 1993 and January 1996, 300 patients older than 18 years of age scheduled for repair of a primary unilateral inguinal hernia were randomized to open mesh or non-mesh repair. Patients could only be enrolled once and were not included if they suffered from bilateral inguinal hernia. Six hospitals participated in the study. The study was designed to mimic clinical reality in general surgery. The conventional method, therefore, was not standardized, and no specialized hernia centers participated in the study. The protocol was approved by the ethics committees of all participating hospitals. Non-mesh repair was performed according to each surgeon's method of choice, provided that 2/0 polypropylene sutures (prolene®; Ethicon, Johnson & Johnson, Sommerville, New Yersey, USA) were used. Mesh repair was performed according to a strict protocol as described by Lichtenstein and Shulman using a Prolene® or Marlex® (C.R. Bard, Billerica, Massachusetts, USA) polypropylene prosthetic mesh of 7.5 x 15 cm.[2]

The primary outcome was clinical outcome including persistent pain and discomfort interfering with daily activity 10 years after the procedure.

Follow-up was done by physical examination at the outpatient clinic after 1 week, 1 month, 6 months, 1 year, 2 years and 3 years. A more meticulous description of the methods has been published previously by Vrijland et al.[1]

Long-term follow-up occurred from June 2005 until January 2006. All patients were asked to complete a questionnaire. If the patients had not replied after a second mailing, they were contacted by telephone, and visited at home if they agreed. Patients were asked whether they suffered from persistent pain and discomfort interfering with daily

activity, paroxysmal pain during intensive activity not interfering with daily activity (such as sports or gardening), chronic obstructive pulmonary desease, obstipation or prostatism. Physical examination was conducted by R.N.v.V or A.R.W, who were blinded of the type of repair that had been performed.

The number of patients suffering from chronic pain was compared between the mesh and non-mesh groups by intention to treat with the Fisher's exact test. All statistical tests were 2-sided; $p \leq 0.05$ was considered significant. All statistical analyses were performed using Statistical Package for Social Sciences for Windows (SPSS Inc., Chicago, Illinois. U.S.A.).

Results

A total of three hundred patients were randomized; eleven patients were excluded. Of these, four patients appeared to have another type of hernia at operation; one patient needed bilateral repair; the operation was cancelled for three patients. In spite of inclusion in the trial two patients underwent laparoscopic inguinal hernia repair and one patient withdrew informed consent before operation.

Of the remaining 289 patients, 143 had been randomized to non-mesh repair and 146 to mesh repair (Figure 1).

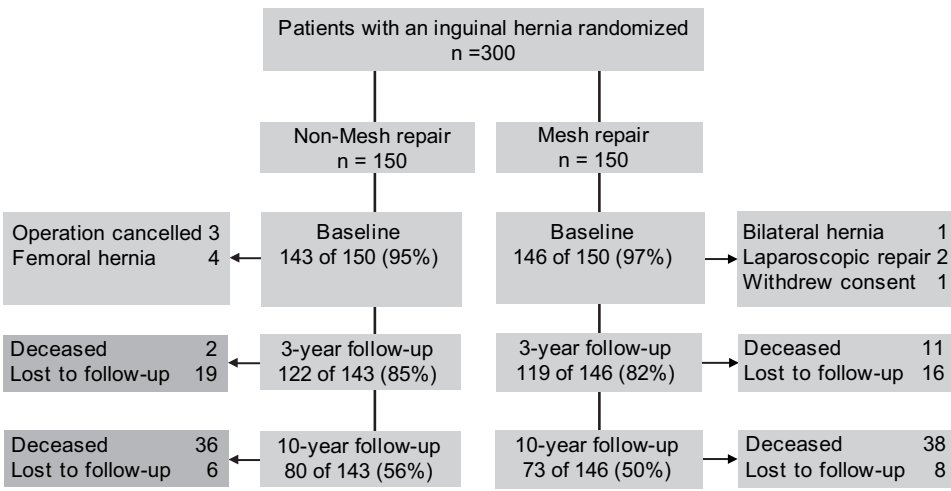

Figure 1. Flowchart of baseline, 3 year and 10 year follow-up periods

The type of hernia repair in the non-mesh repair group was Bassini-McVay in 75 patients (52 per cent), Shouldice in 36 (25 per cent), Bassini in 26 (18 per cent) and McVay in 3 (2 per cent). Three patients received a mesh because the surgeon decided intra-operatively that a mesh would be preferable. In the mesh repair group, one patient received a resorbable polyglactin 910 mesh (Vicryl®; Ethicon, Johnson & Johnson), which was used in error. In addition, seven patients did not receive a mesh repair; these operations were marked as conversions.

A total of 87 patients (30 per cent) died within the long-term follow-up period (Figure 1); the causes of death were unrelated to the performed inguinal hernia repair. Forty-nine patients (17 per cent) were lost to follow-up. In the outpatient clinic, 153 patients were physically examined; 80 in the non-mesh group and 73 in the mesh group. Median long-term follow-up of these patients was 128 months (range 109-148) and 129 months (range 112-147) for non-mesh repair and for mesh repair, respectively (table 1).

Table 1. Characteristics of patients with inguinal hernia in the 10 year follow-up period

	Total (n = 153)		**Non-Mesh repair (n = 80)**		**Mesh repair (n = 73)**	
Men	149	(97%)	78	(97%)	71	(97%)
Age (years): median (range)	66	(30-96)	62	(30-96)	66	(35-87)
Follow-up (months): median* (range)	129	(109-148)	128	(109-148)	129	(112-147)
Body mass index** (range)	24.6	(18.6-34.5)	24.4	(19.0-33.9)	24.4	(18.6-34.5)
Contralateral hernia (%)	35	(23)	20	(35)	15	(21)
COPD (%)	17	(11)	7	(9)	10	(14)
Constipation (%)	7	(5)	4	(5)	3	(4)
Prostatic disease (%)	32	(21)	13	(16)	19	(26)
Level of expertise: Resident, senior resident, surgeon (%)	54 (35%)	11 (7%)	29 (36%)	46 (58%)	25 (34%)	6 (8%) 42 (58%)

* Median follow-up censored at the time of last physical examination

** The body mass index was calculated as the weight in kilograms divided by the square of height in meters

The type of hernia repair in the non-mesh repair group consisted of Bassini-McVay in 41 patients (51 per cent), Shouldice in 16 (20 per cent), Bassini in 20 (25 per cent) and McVay in 3 (4 per cent). Of the 3 patients of the non-mesh group that were converted at baseline to receive a mesh, one patient deceased and 2 did not report any form of pain.

In the mesh group, seven patients were converted at baseline to receive a non-mesh repair; 3 of these patients died and 4 were lost to follow-up.

After a median follow-up of 129 months none of the patients in either the non-mesh or mesh group suffered from persistent pain and discomfort interfering with daily activity (Figure 2).

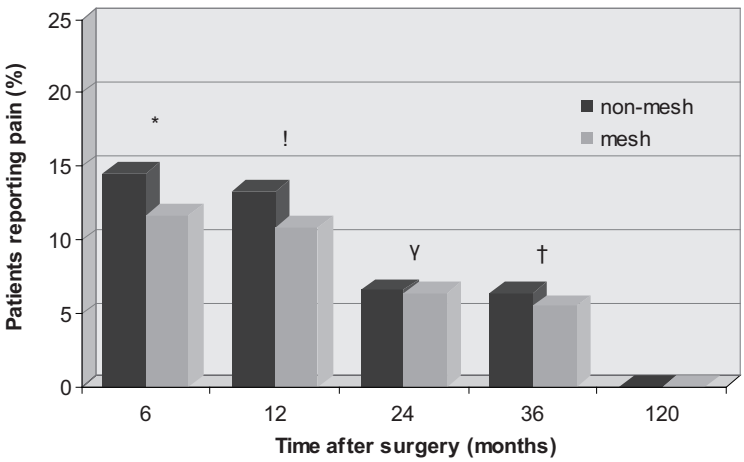

Figure 2. Proportion of patients reporting pain following non-mesh and mesh inguinal hernia repair

*p = 0.307 !p = 0.339 γp = 0.571 †p = 0.464 (Chi-square Test)

Some patients reported paroxysmal pain during intensive activity not interfering with daily activity (such as sports or gardening), which did not last longer than one day. This type op paroxysmal pain occurred in 10 per cent of the patients in the non-mesh group and 14 per cent of patients in the mesh group. The type of hernia repair was not significantly correlated with paroxysmal pain during intensive activity not interfering with daily activity (p = 0.31). In the non-mesh repair group seven patients (9 per cent) suffered from numbness in the groin region compared with 14 patients (19 per cent) in the mesh repair group (p = 0.047). Chronic groin pain was not correlated with the level of experience of the surgeon (p = 0.449) (Table 1). Surgeons with a higher level of expertise in hernia surgery performed more non-mesh operations; 81 per cent of the Shouldice operations and 81 per cent of the Bassini operations. No significant correlation between age, obesity, history of pulmonary disease, constipation, or prostatic disease with groin pain was found (Table 1).

Discussion

According to a review study by the EU Hernia Trialist Collaboration reviewing all randomized or quasi-randomized trials comparing open-mesh with non-mesh methods published until 1999, a minority of studies reported a measure of postoperative chronic pain.[3] Of the 15 trials included in the review study 12 compared a flat mesh to non-mesh repairs. The mean or median duration of follow-up of all included 15 studies ranged from 6 days to 5 years. There were few reported cases of chronic pain, with reported rates similar for the mesh and non-mesh group.[3]

Individual patient data was collected and a meta-analysis was conducted and published by the Cochrane Library.[4] This review reported 17 studies in which a flat mesh was compared to non-mesh hernia repair including three previously unpublished studies identified by the EU Trialist Collaboration. The results suggested that persisting pain was less frequent after mesh repair than after non-mesh repair but this result was dependent on one trial by Koninger et al. and data were not available for 11 of the total of 20 trials included in the study.[4,5]

Poobalan et al.[6] reviewed studies investigating postoperative pain after inguinal hernia repair that were published between 1987 and 2000 almost simultaneously to the review mentioned above. Two studies were reported in which open flat mesh and non-mesh repair was compared, the same study reported by the EU Trialist Collaboration.[7] This included a nonrandomized study by Amid et al. reporting less chronic pain with mesh repair.[8]

Of the studies published after 1999, Nordin et al. reported no significant difference in chronic pain after 3 years between the Shouldice and Lichtenstein repair (4,2 and 5,6 per cent, respectively), as our long-term data at 3 years of follow-up suggest.[9] Miedema et al. reported a higher incidence of chronic pain after the Lichtenstein repair compared with Shouldice repair (38 and 7 per cent, respectively; $p < 0,05$).[9,10] However follow-up included only 60 per cent of patients.

Long term follow-up remains difficult to obtain because many patients undergoing hernia repair are lost to follow-up, do not show up or have died. The mean age at long-term follow-up was 66 years. Although time-consuming and incomplete because of patients who had died or are lost to follow-up, our data indicate that long-term follow-up is of great importance for research regarding inguinal hernia repair.

In our study none of patients from either group experienced persistent pain interfering with daily activity, suggesting that neuropathic pain that is caused by neurplastic changes in the central nervous system following nerve injury in the inguinal region, disappears over time.[11] Our data, therefore, provide insight into the course of chronic pain that is supposed to be predominantly caused by neuroplastic changes in the central nervous system.

In conclusion, our 10 year follow-up study provides evidence that mesh repair of inguinal hernia is equal to non-mesh repair with respect to long-term chronic pain. It is the only study to provide a follow-up of longer than 5 years. An important new finding is that chronic postoperative pain of neuropathic or somatic origin, seems to dissipate over time.[6,11,12] Because chronic pain can be debilitating, this knowledge is very interesting from patient's perspective and, therefore, from the doctor perspective as well.

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References

1. Vrijland WW, van den Tol MP, Luijendijk RW, et al. Randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia. Br J Surg 2002;89(3):293-7.
2. Lichtenstein IL, Shulman AG. Ambulatory outpatient hernia surgery. Including a new concept, introducing tension-free repair. Int Surg 1986;71(1):1-4.
3. Collaboration EH. Mesh compared with non-mesh methods of open groin hernia repair: systematic review of randomized controlled trials. Br J Surg 2000;87(7):854-9.
4. Scott NW, McCormack K, Graham P, Go PM, Ross SJ, Grant AM. Open mesh versus non-mesh for repair of femoral and inguinal hernia. Cochrane Database Syst Rev 2002(4):CD002197.
5. Koninger JS, Oster M, Butters M. [Management of inguinal hernia--a comparison of current methods]. Chirurg 1998;69(12):1340-4.
6. Poobalan AS, Bruce J, King PM, Chambers WA, Krukowski ZH, Smith WC. Chronic pain and quality of life following open inguinal hernia repair. Br J Surg 2001;88(8):1122-6.
7. McGillicuddy JE. Prospective randomized comparison of the Shouldice and Lichtenstein hernia repair procedures. Arch Surg 1998;133(9):974-8.
8. Amid PK, Shulman AG, Lichtenstein IL. Simultaneous repair of bilateral inguinal hernias under local anesthesia. Ann Surg 1996;223(3):249-52.
9. Nordin P, Bartelmess P, Jansson C, Svensson C, Edlund G. Randomized trial of Lichtenstein versus Shouldice hernia repair in general surgical practice. Br J Surg 2002;89(1):45-9.
10. Miedema BW, Ibrahim SM, Davis BD, Koivunen DG. A prospective trial of primary inguinal hernia repair by surgical trainees. Hernia 2004;8(1):28-32.
11. Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: risk factors and prevention. Lancet 2006;367(9522):1618-25.
12. Cunningham J, Temple WJ, Mitchell P, Nixon JA, Preshaw RM, Hagen NA. Cooperative hernia study. Pain in the postrepair patient. Ann Surg 1996;224(5):598-602.

Chapter 5

Patent Processus Vaginalis in the Adult as a Risk Factor for the Occurrence of Indirect Inguinal Hernia

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Abstract

Background: Inguinal hernias are a common entity with nearly 33,000 repairs annually in the Netherlands and over 800,000 in the USA. The aim of the present study is to determine whether a laparoscopically diagnosed patent processus vaginalis (PPV) is a risk factor for the development of groin hernia.

Methods: The study population was originally composed of 599 consecutive cases (189 male, 32%) of laparoscopic transperitoneal surgery for different indications performed in 4 teaching hospitals in the Netherlands between November 1998 and February 2002. During laparoscopy, the deep inguinal ring was inspected bilaterally. The PPV group was compared with the obliterative processus vaginalis (OPV) group.

Results: After a mean follow-up of 5.5 years, the studied population consisted of 337 cases (94 male, 28%). In this study 12% of the studied population appeared to have PPV in adult life. The per centage PPV of our study group is much higher than the per centage of hernia repairs performed in the Dutch population. A greater proportion (12%) of hernia repairs in the PPV group was found as compared with the OPV group (3%). The chance of developing an inguinal hernia within 5.3 years is four times higher in the group with PPV. No significant correlation between age and the prevalence of PPV was observed.

Conclusion: This study demonstrates that PPV is an etiologic factor and a risk factor for acquiring an indirect inguinal hernia in adults.

Introduction

In childhood indirect inguinal hernias arise from incomplete obliteration of the processus vaginalis, the embryological protrusion of peritoneum that precedes testicular descent into the scrotum. The testes originate along the urogenital line in the retroperitoneal space and migrate during the second trimester of pregnancy to the internal inguinal ring. During the last trimester they proceed through the abdominal wall via the inguinal canal and descend into the scrotum, the right slightly later than the left.[1] The processus vaginalis extends from the inguinal ring superiorly, medially, and anteriorly to the cord structures and to the uppermost portion of the tunica vaginalis. The cord in the male and the round ligament in the female curve laterally and anteriorly to the inferior epigastric vessels.[2]

The processus vaginalis normally obliterates postnatally except for the part covering for the testes.[3] Failure of this obliterative process results in a patent processus vaginalis (PPV); a possible congenital indirect inguinal hernia.[4]

The incidence of PPV in the first 2 months of life is 63% with a steady decrease until 2 years of age.[5] This decrease is thought to be due to the natural process of obliteration of PPV, with a 60% patency rate at birth and subsequent obliteration in 20% of patients over the next 2 years. The theory that one half of the remaining 40% will develop an inguinal hernia some time during their lives,[6] is based on autopsy findings of 15 to 30% PPV.[1] Because most studies describe PPV only in children, it is unknown whether PPV is a risk factor for developing indirect hernia and if so in what per centage.

The aim of the present study is to determine in what degree PPV is a risk factor for the development of inguinal hernia in adults.

Materials and Methods

Study population

The study population previously described was composed of 599 consecutive patients (189 male, 32%) who underwent laparoscopic transperitoneal surgery for different indications performed in 4 teaching hospitals in the Netherlands between November 1998 and February 2002.[7] During laparoscopy the deep inguinal ring was inspected bilaterally. Patients with a history of hernia repair and groin pain were excluded from participation, as well as patients who underwent primary laparoscopy in the groin region. During operation a patent processus vaginalis was identified as a peritoneal protrusion through the deep inguinal ring. A dimple without hernial sac (Figure 1) or a larger peritoneal protrusion with hernial sac (Figure 2) were defined as a partially or non-obliterated processus vaginalis. When PPV was diagnosed, it was recorded on video or photographed.

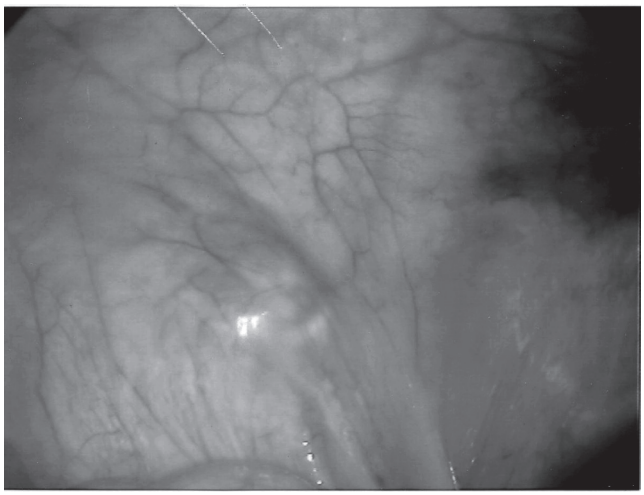

Figure 1: Patent Processus Vaginalis : dimple without hernial sac

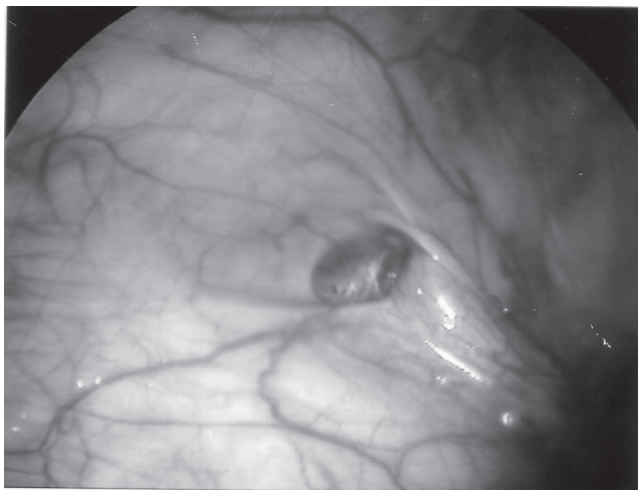

Figure 2: Patent Processus Vaginalis : larger defect with hernial sac

Follow-up

Patients were identified from a resident database and hospital record procedure code. Case notes, records and operative reports were obtained. Each patient received a questionnaire with questions concerning groin pain and a history of inguinal operations. Patients with inguinal hernia were clinically diagnosed by the general practitioner or the surgeon. The PPV group was compared with the obliterative processus vaginalis (OPV) group.

Statistical analysis

A Fisher's exact test and logistic regression was performed to compare occurrence of groin hernias between patients with and without PPV. Means of baseline characteristics were compared using an unpaired t-test. A p-value of 0.05 (two-sided) was considered the limit of significance. The Mann-Whitney-U test was performed to analyse any differences between the follow-up time of both groups.

The Chi-square test was performed to analyse correlations between age and the prevalence of PPV as well as correlations between the increased intra-abdominal pressure and the development of inguinal hernia.

Kaplan-Meier survival curves were constructed to assess differences in groin pain/ inguinal hernia free survival in both groups. All statistical analyses were performed using Statistical Package for Social Sciences for Windows (SPSS Inc., Chicago, Illinois. U.S.A.).

Results

In 39 patients the groin could not be inspected during operation due to adhesions. These patients were excluded from follow-up. Forty nine patients were deceased during the follow-up period. Partially because of a migrating population, 174 (29%) patients were lost to follow-up (Figure 3).

The studied population consisted of 337 cases (94 male, 28%). Two hundred and eighty five patients in the OPV group and 52 in the PPV group. The mean follow-up time was 5.5 years in the obliterated processus vaginalis group (OPV) and 5.3 years in the PPV group.

The characteristics of patients assessed at follow-up were similar to those at the previously reported baseline study[7]: mean age 50, 28% men (Table 1).

Table 1

	Total (n = 337)		**Obliterated Processus Vaginalis (n = 285)**		**Patent Processus Vaginalis (n = 52)**	
Men	94 (28%)		65 (23%)		29 (56%)	
Age (years): mean (range)	50	(14-89)	50	(14-89)	50	(22-79)
Diagnosed inguinal hernia	14	(4 %)	8	(3 %)	6	(12 %)
Follow-up (years): mean (range)	5.5	(3.24-7.64)	5.5	(3.61-7.64)	5.3	(3.24-6.92)

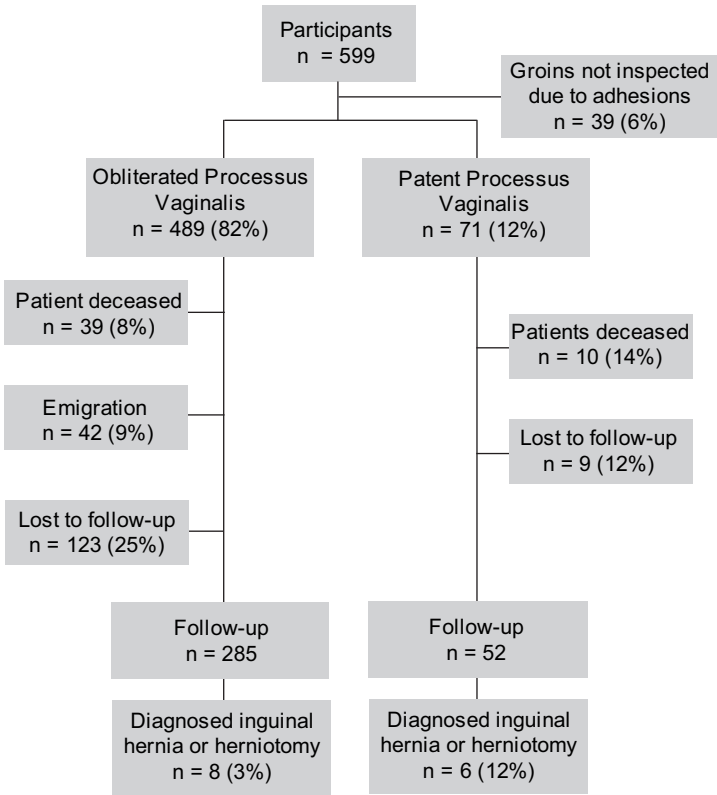

Figure 3: Flow chart

Table 2: Prevalence of patent processus vaginalis

Age categories (years)	Patent Processus Vaginalis	Total (%)	
< 30	8	42	19%
30-40	9	63	14%
40-50	8	68	12%
50-60	10	64	16%
60-70	8	52	15%
> 70	9	48	19%
Total	52	337	15%

Indications for laparoscopy were cholecystectomy (56%), appendectomy (21%), diagnostic laparoscopy (16%), and other indications (7%).

Aged under thirty, 19% of all patients at follow-up time had PPV. Between the age of thirty and forty 14% was found to have PPV. Between forty and fifty 12%, between fifty and sixty 16%, between sixty and seventy years 15%, and over seventy years 19% (Table 2).

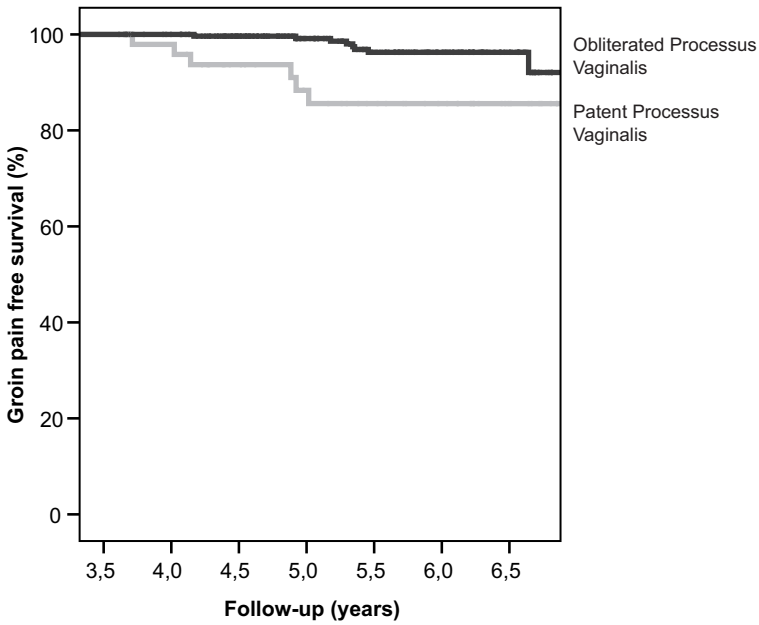

Figure 4. Kaplan-Meier curve for the development of inguinal hernia, comparing the patent processus vaginalis (PPV) group with the obliterated processus vaginalis group (OPV). There were significantly more inguinal hernias in the PPV group ($p < 0.01$).

No significant correlation between age and the prevalence of PPV was observed.

Gastrointestinal obstipation, benign prostate hypertophy, COPD and congenital anomalies did not correlate significantly with the incidence of developing an inguinal hernia in both the PPV group as the OPV group.

Figure 4 shows the incidence of a diagnosed inguinal hernia in the follow-up period. A greater proportion of patients in the PPV group is reported to have an inguinal hernia (12%) compared to the OPV group (3%) ($p < 0.01$). The chance of developing an inguinal hernia within 5.3 year in patients diagnosed with PPV is four times higher compared to patients with OPV (Odds ratio 4.3).

Discussion

The absence of the posterior rectus sheath caudally to the arcuate line and the presence of a rather insubstantial transversalis fascia, unsupported by muscle or aponeurosis, can be considered an evolutionary defect in humans.[4] The change from quadrupedal to bipedal locomotion might have lead to a greater propensity to develop inguinal hernias. In humans the upright posture causes gravitational stress to pass down to the lower abdominal wall, which structurally is not designed for such stress.[4]

The development of the processus vaginalis, migration into the scrotum, and finally obliteration, is intimately linked to the descent of the testis from the abdominal cavity into the scrotum. A similar process takes place in the female foetus, with the processus vaginalis and the round ligament descending into the labia majora but with the descent of the ovary arrested at the brim of the true pelvis.[4]

Women suffering from unilateral inguinal hernias more commonly have a contralateral PPV than do men. Since PPV is more commonly patent in women, a higher incidence of bilateral clinically apparent inguinal hernias is to be expected, if the presence of PPV is the key to the development of a clinically apparent hernia. It clearly appears that the presence of PPV alone is not the determing factor in the development of a clinically inguinal hernia.[6]

Historically, abdominal herniation has been attributed to a disparity between visceral pressure and the resistance of the musculature.[8] Increased intraabdominal pressure has been implicated in the etiology of inguinal hernias. The effect of increased pressure on PPV has received little attention in the literature. Gastrointestinal obstipation, benign prostate hypertophy, COPD, and congenital anomalies do not effect the incidence of patency of PPV, but do increase the frequency of bilateral inguinal hernias. This supports the contention that PPV is not an inguinal hernia, but a potential hernia.[6]

Groin hernia repair is the most frequent operation in general surgery. The number of times it is performed each year is approximately 800.000 in the USA,[9] 80.000 in the UK[10] and 33.000 in The Netherlands.[11] The incidence of indirect inguinal hernias in children is well described in the literature. In young infants the incidence of a contralateral patent processus vaginalis (PPV) may be as high as 80 per cent. Nevertheless the incidence of indirect inguinal hernia is approximately 1 per cent to 5 per cent, with male to female ratio of 10:1.[2] PPV will evolve into a contralateral hernia in 5-10 per cent in children who undergo unilateral inguinal hernia repair.[12] A 10 per cent incidence of contralateral hernia is not enough to justify routine exploration and surgery for PPV.[13] However, extended follow-up (20 years) reported a 29 per cent incidence of developing contralateral inguinal hernia after unilateral repair in children younger than 10 years of age.[3] The debate centers

on whether or not early bilateral exploration and repair outweigh the potential risk of iatrogenic injury to the vas deferens or gonad in children.[14]

PPV does not necessarily represents the development of inguinal hernia. The reported incidence of PPV in adults in our previous study (12%), is much lower than the 20 to 40% described in the literature.[6] According to Rowe et al. the life-time risk of developing an inguinal hernia should be approximately 50 per cent of all patients with PPV.[6] In 5.3 years we found 6 inguinal hernias in 52 patients (12%) with PPV which is a significant higher number than found in the larger OPV group.

The incidence of PPV differs markedly between sexes. There is an incidence of about 1:10 in women and 1:3 in men. A greater difference between sexes is reported in the incidence of indirect hernias: the incidence is about 1:100 in Women and 1:20 in men.

Four of the six inguinal hernias proved to be indirect hernias during inguinal hernia repair. Although physical examination in two patients resulted in the suspicion of indirect hernias, we realize that physical examination is not specific in the determination of direct or indirect inguinal hernia.

We have determined to what extent PPV is a risk factor for the development of groin hernia. The chance of developing an inguinal hernia within 5.3 year in patients diagnosed with PPV appeared to be four times higher compared to patients with OPV. To determine whether this chance is large enough to justify closure of PPV by means of herniorraphy in advance, a randomized clinical trial is necessary.

In conclusion, asymptomatic PPV frequently exists in adult life. The prevalence of PPV does not increase or decrease significantly with age.

Many factors influence the etiology of indirect inguinal hernia in adults. Clearly PPV is one of these factors.

Acknowledgements

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References

1. Brendan Devlin H KA, O'Dwyer PJ, Bloor K (1998) Management of Abdominal Hernia's. ed 2nd, Chapman & Hall Medical London.
2. Kapur P, Caty MG, Glick PL (1998) Pediatric hernias and hydroceles. Pediatr Clin North Am 45:773-789.
3. McGregor DB, Halverson K, McVay CB (1980) The unilateral pediatric inguinal hernia: Should the contralateral side by explored? J Pediatr Surg 15:313-317.
4. Abrahamson J (1998) Etiology and pathophysiology of primary and recurrent groin hernia formation. Surg Clin North Am 78:953-972, vi.
5. Pellegrin K, Bensard DD, Karrer FM, Meagher DP, Jr. (1996) Laparoscopic evaluation of contralateral patent processus vaginalis in children. Am J Surg 172:602-605; discussion 606.
6. Rowe MI, Copelson LW, Clatworthy HW (1969) The patent processus vaginalis and the inguinal hernia. J Pediatr Surg 4:102-107.
7. van Wessem KJ, Simons MP, Plaisier PW, Lange JF (2003)The etiology of indirect inguinal hernias: congenital and/or acquired? Hernia 7:76-79.
8. Read RC (2003) Recent advances in the repair of groin herniation. Curr Probl Surg 40:13-79.
9. Rutkow IM (2003) Demographic and socioeconomic aspects of hernia repair in the United States in 2003. Surg Clin North Am 83:1045-1051, v-vi.
10. Kingsnorth AN, Gray MR, Nott DM (1992) Prospective randomized trial comparing the Shouldice technique and plication darn for inguinal hernia. Br J Surg 79:1068-1070.
11. www.prismant.nl (2004) National Medical Registration, The Netherlands.
12. Geisler DP, Jegathesan S, Parmley MC, McGee JM, Nolen MG, Broughan TA (2001) Laparoscopic exploration for the clinically undetected hernia in infancy and childhood. Am J Surg 182:693-696.
13. Ikeda H, Suzuki N, Takahashi A, Kuroiwa M, Sakai M, Tsuchida Y (2000) Risk of contralateral manifestation in children with unilateral inguinal hernia: should hernia in children be treated contralaterally? J Pediatr Surg 35:1746-1748.
14. Yerkes EB, Brock JW, 3rd, Holcomb GW, 3rd, Morgan WM, 3rd (1998) Laparoscopic evaluation for a contralateral patent processus vaginalis: part III. Urology 51:480-483.

Chapter 6

Long-Term Follow-Up of a Randomised Clinical Trial of Non-Mesh versus Mesh Repair of Primary Inguinal Hernia

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Abstract

Background: Open mesh or non-mesh inguinal hernia repair may influence the incidence of chronic postoperative pain differently.

Methods: A total of 300 patients scheduled for repair of a primary unilateral inguinal hernia were randomized to non-mesh or mesh repair. The primary outcome measure was clinical outcome including persistent pain and discomfort interfering with daily activity. Long-term results at 3 years of follow-up have been published. Included here are 10-year follow-up results with respect to pain.

Results: Of the 300 patients, 87 patients (30%) died and 49 patients (17%) were lost to follow-up. A total of 153 were physically examined in the outpatient clinic after a median long-term follow-up of 129 months (range, 109 to 148 months). None of the patients in the non-mesh or mesh group suffered from persistent pain and discomfort interfering with daily activity.

Conclusion: Our 10-year follow-up study provides evidence that mesh repair of inguinal hernia is equal to non-mesh repair with respect to long-term persistent pain and discomfort interfering with daily activity. An important new finding from the patient's perspective is that chronic postoperative pain seems to dissipate over time.

Introduction

Groin hernia repair is the most frequently performed operation in general surgery. Approximately 800.000 repairs are performed in the USA and 33.000 in The Netherlands annually.[1,2] Relatively modest improvements of clinical outcomes or savings of resource use in inguinal hernia repair would have a significant medical and economical impact.[3]

Recurrence rates after non-mesh suture repair of inguinal hernia vary between 0.2 and 33 per cent, depending on surgical method, experience, type of hospital and length of follow-up.[3-10] Recurrence rates currently represent the most important endpoint in hernia surgery, but data on long-term rates of recurrence in mesh techniques are hardly available.[11] Follow-up of recurrence rates after 10 years needs to be assessed to determine whether mesh repair is favourable in the long term.

In 2002 we published the short-term results (up to 3 years) of a randomized controlled trial, which indicated that mesh repair is superior to non-mesh repair.[12] Disconcerting data indicate that surgeons are still performing non-mesh repair.[13]

The aim of this study was to determine long-term results and evaluate long-term recurrences in mesh or non-mesh inguinal hernia repairs. Therefore, patients who participated in our randomized controlled short-term trial on non-mesh versus mesh inguinal hernia repair were ask to complete a questionnaire and visit the outpatient clinic.

Patients and Methods

Between September 1993 and January 1996, patients older than 18 years scheduled for repair of a primary unilateral inguinal hernia were randomized to non-mesh or mesh repair. Patients could only be enrolled once and were not included if they suffered from bilateral inguinal hernia. Patients were informed about the trial both verbally and in writing. Six hospitals participated in the study.

The study was designed to mimic clinical reality in general surgery. The participating centers could choose the non-mesh technique they were most familiar with. Included were the techniques of Shouldice, McVay, Bassini and Bassini-McVay; a Dutch hybrid technique combining Bassini's and McVay's (ligature of conjoint tendon to Coppers ligament) principles. All techniques were standardized and well documented in the protocol. No specialized hernia centers participated in the study.

Randomization was achieved by calling an independent randomization centre, were computer-generated lists were available, stratified by hospital. After randomization, conversions from non-mesh technique to mesh technique or vice versa were noted.

The protocol was approved by the ethics committees of the participating hospitals, and all patients gave informed consent.

Non-mesh repair was performed according to the surgeons' method of choice, provided that 2/0 polypropylene sutures (prolene®; Ethicon, Johnson & Johnson, Sommerville, New Yersey, USA) were used. Mesh repair was performed according to a strict protocol as described by Lichtenstein and Shulman[14] using a Prolene® or Marlex® (C.R. Bard, Billerica, Massachusetts, USA) polypropylene prosthetic mesh of 7.5 x 15 cm.

Follow-up was done by physical examination at the outpatient clinic after 1 week, 1 month, 6 months, 1 year, 2 years and 3 years. A more meticulous description of the methods has been published previously.[12]

Long-term follow-up occurred from June 2005 until January 2006. All medical records were reviewed for evidence of recurrences after the 3 year control visit. All patients were asked to complete a questionnaire. Patients were asked whether they had suffered a recurrence, a contralateral hernia, COPD, obstipation, prostatism, or obesity. Patients were also asked whether they had undergone hernia repair since their last visit. Patients were invited to visit the outpatient clinic, where patient history was taken and physical examination was performed. The physical examination was done by one of the authors who was unaware of the type of repair that had been performed. The groin region was examined physically for recurrence of inguinal hernia, which was defined as a symptomatic or asymptomatic defect (bulge or weakness) in the abdominal wall of the operative area with herniation of abdominal contents outside the external ring, exacerbated by Valsalva manoeuvre. Ultrasound examination was performed when physical examination was not inconclusive. If the patients had not replied after a second mailing, they were contacted by telephone, and visited at home if possible.

Statistical Analysis

Per centages and continuous variables were compared with the use of Fisher exact test and the Mann-Whitney test, respectively. Categorical variables in each arm of the two groups were compared with the chi-square test. The cumulative per centages of patient with recurrences over time were calculated and compared with the use of Kaplan-Meier curves and log-rank tests. Multivariate analysis of various factors was performed with Cox regression analysis. To evaluate the pattern of recurrence over time, we constructed a life table with monthly intervals noting the standard error of the mean. Factors like age, bilateral disease, history of contralateral hernia repair, history of pulmonary disease, prostatic disease, constipation, prostatism, surgical expertise, technique of repair were analysed with logistic regression for their correlation with recurrence.

All statistical tests were 2-sided; $p \leq 0.05$ was considered significant. The primary analysis was performed on an intention-to-treat basis. All statistical analyses were performed using Statistical Package for Social Sciences for Windows (SPSS Inc., Chicago, Illinois. U.S.A.).

Results

At baseline, three hundred patients were randomized. Eleven patients were excluded. Of the remaining 289 patients, 143 had been randomized to non-mesh repair and 146 to mesh repair. (Figure 1)

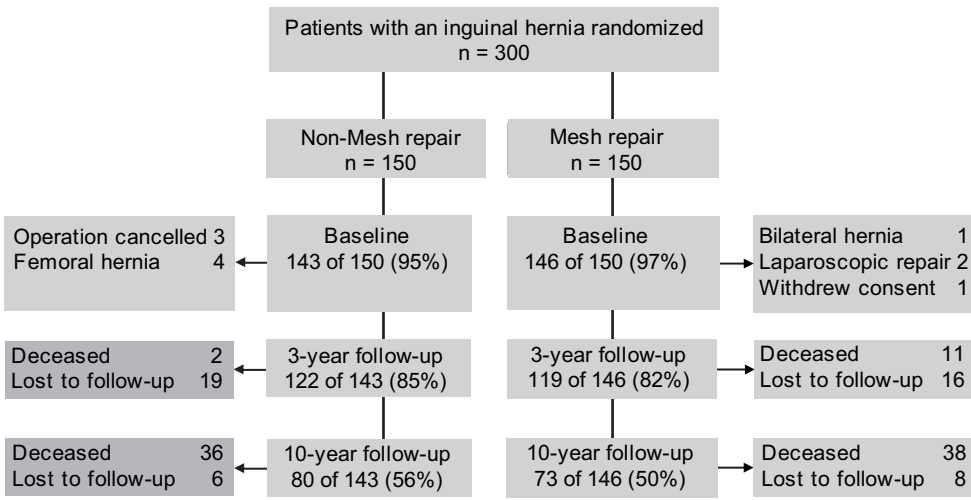

Figure 1. Flowchart of baseline, 3 year and 10 year follow-up periods.

The type of hernia repair in the non-mesh repair group was Bassini-McVay in 75 patients (52 per cent), Shouldice in 36 (25 per cent), Bassini in 26 (18 per cent) and McVay in 3 (2 per cent). In ten cases the randomization was converted; 7 conversions from mesh to non-mesh technique and 3 conversions from non-mesh to mesh.

In the mesh repair group, one patient received a resorbable polyglactin 910 mesh (Vicryl®; Ethicon, Johnson & Johnson) which was used in error.

Follow-up

Thirty per cent of all patients died during the long-term follow-up period. The causes of death were not related to the performed inguinal hernia repair. Basic characteristics weren't significantly different at follow-up time (Table 1).

Table 1. Characteristics of patients with inguinal hernia in the 10 year follow-up period

	Total (n = 153)		Non-Mesh repair (n = 80)		Mesh repair (n = 73)	
Men	149	(97%)	78	(97%)	71	(97%)
Age (years): median (range)	66	(30-96)	62	(30-96)	66	(35-87)
Follow-up (months): median* (range)	129	(109-148)	128	(109-148)	129	(112-147)
Body mass index** (range)	24.6	(18.6-34.5)	24.4	(19.0-33.9)	24.4	(18.6-34.5)
Contralateral hernia (%)	35	(23)	20	(35)	15	(21)
COPD (%)	17	(11)	7	(9)	10	(14)
Constipation (%)	7	(5)	4	(5)	3	(4)
Prostatic disease (%)	32	(21)	13	(16)	19	(26)
Level of expertise: Resident, senior resident, surgeon (%)	54	88 (58%)	29	46 (58%)	25	42 (58%)
	(35%)		(36%)		(34%)	

* Median follow-up censored at the time of last physical examination

** The body mass index was calculated as the weight in kilograms divided by the square of height in meters

The type of hernia repair in the non-mesh repair group consisted of Bassini-McVay in 41 patients (51 per cent), Shouldice in 16 (20 per cent), Bassini in 20 (25 per cent) and McVay in 3 (4 per cent).

At time of follow-up, 3 of 7 patients with a conversion in the mesh group had died and four were lost to follow-up. Of patients in the non-mesh group whose procedure was converted to mesh repair, three had died and two who visited the outpatient clinic had no complaints or recurrence.

Recurrences

After a median follow-up of 129 months, eighteen recurrences were found in the non-mesh repair group and one in the mesh repair group (Figure 2) ($p = 0.005$).

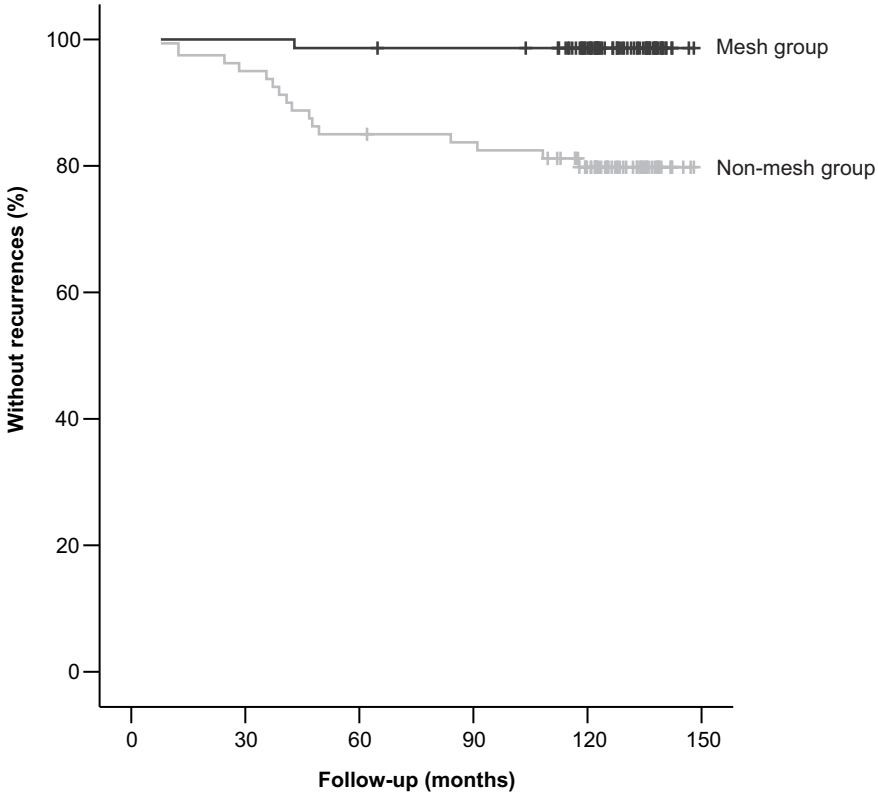

Figure 2. Kaplan-Meier curves for recurrence of hernia after repair of a primary unilateral inguinal hernia according to whether the patient was assigned to non-mesh group (n = 80) or mesh group (n = 73). Numbers at risk: 153. There were significantly fewer recurrences in patients who were assigned to the mesh group. (p = 0.005)

The only recurrence in the mesh group occurred in the patient who received a resorbable mesh in error. Table 2 shows the 10-year cumulative recurrence rates in the non-mesh and mesh repair groups. The 10-year recurrence rate of mesh technique using prolene and marlex meshes was zero.

Table 2. Rate of recurrence after non-mesh or mesh inguinal hernia repair

Type of repair	Number of patients	Number of recurrences	10 year cumulative rate of recurrence	P value
Non-mesh repair	80	18	17% ± 4	*P* = 0.005*
Mesh repair	73	1	1% ± 1	
Total	153	19		

*P value was obtained by stratified log-rank test

In the non-mesh repair group, 8 recurrences were found after inguinal hernia repair according to the Bassini-Mcvay technique, 2 after the Shouldice technique, 7 after the Bassini technique and 1 after the Mcvay technique. Recurrences after Shouldice operations tend to be less compared with the Bassini operation (p = 0.053).

No significant correlation was found between the level of experience of the surgeon and recurrence (p = 0.5). Surgeons with a higher level of expertise in hernia surgery performed more non-mesh operations; 81 per cent of the Shouldice operations and 81 per cent of the Bassini operations.

Twenty patients (27%) in the non-mesh repair group had a history of contralateral repair, or developed a contralateral inguinal hernia within 129 months, and 15 patients (19%) in the mesh repair group. There was no significant correlation between the development of contralateral hernia and the group of hernia repair, which emphasises that there is probably no difference in collagen weakness between the two groups (p = 0.57).

There was no significant correlation between age, obesity, history of pulmonary disease, constipation, or prostatic disease with recurrence.

Discussion

This study provides evidence that mesh repair of inguinal hernia is superior to non-mesh repair in the long-term. An important finding is that recurrences of inguinal hernia continue to occur up to 10 years after conventional hernia repair. It is therefore likely that recurrence rates are generally underestimated, because most studies are either not prospective or do not include long-term follow-up.[15,16]

It is well known that the reported recurrence rates are influenced not only by surgical expertise and method of repair, but also by the length and method of follow-up.[4,15]

The level of expertise and surgical technique did not correlate significantly with recurrence in this study, although comparing small numbers, recurrences after Shouldice operations tend to be less common with Bassini operations (p = 0.053). An expertise based trial design for the non-mesh group was used, which will enhance the alidity, applicability, amd feasibility of the results.[17] With a physical examination in all remaining patients after a follow-up period of 10 years, the results of this study are probably give a reliable estimate of long-term recurrence rates.[4]

The importance of an adequate length of follow-up is shown by the fact that 50 per cent of recurrences occurred after the 3-year follow-up period in our study.[15]

Thus, long-term outpatient follow-up is mandatory in any study of inguinal hernia recurrence.

However, long term follow-up remains difficult to obtain as many patients undergoing hernia repair are lost to follow-up, do not show up or have died.[6,9,18] Although time-consuming and incomplete because of patients who have died or are lost to follow-up our data indicate that long-term follow-up is of eminent importance for research regarding inguinal hernia repair.

The golden standard of hernia repair changed rigorously from non-mesh to mesh repair within ten years. Still, a mesh-based technique is used in 78 per cent of the inguinal repair operations in The Netherlands in 2001.[13] This per centage is in concordance with data reported from other countries.[19-21]

Data summarized by the EU hernia Trialists Collaboration suggest a 60 per cent decrease in relative risk of recurrence with the use of synthetic meshes compared to conventional surgery.[22] These data indicate that the use of synthetic mesh reduces the risk of groin hernia recurrence by around 50 per cent, regardless of method of placement.[11,22]

Irving L. Lichtenstein et al. established the basis for current inguinal hernia surgery and reported 1000 consecutive patients with primary mesh repair followed-up from 1 year to 5 years with no recurrences.[14] Excluding the patient in this study who received a resorbable mesh, our recurrence rate was comparable to the study of Lichtenstein and other studies describing low recurrence rates.[23-26] These excellent outcomes established the Lichtenstein tension-free hernioplasty as the gold standard for primary inguinal hernia surgery in The Netherlands.

In conclusion, our study is the first to provide long-term follow-up of a prospective randomized study of mesh versus non-mesh inguinal hernia repair. It proves that mesh repair is superior to non-mesh repair in a preponderantly male population. We conclude that to reduce recurrence rates, non-mesh primary inguinal hernia repair in the adult should be completely abandoned.

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References

1. Rutkow IM. Demographic and socioeconomic aspects of hernia repair in the United States in 2003. Surg Clin North Am 2003;83(5):1045-51, v-vi.
2. www.prismant.nl. National Medical Registration 2004.
3. Simons MP, Kleijnen J, van Geldere D, Hoitsma HF, Obertop H. Role of the Shouldice technique in inguinal hernia repair: a systematic review of controlled trials and a meta-analysis. Br J Surg 1996;83(6):734-8.
4. Beets GL, Oosterhuis KJ, Go PM, Baeten CG, Kootstra G. Longterm followup (12-15 years) of a randomized controlled trial comparing Bassini-Stetten, Shouldice, and high ligation with narrowing of the internal ring for primary inguinal hernia repair. J Am Coll Surg 1997;185(4):352-7.
5. de Wilt JH, Ijzermans JN, Hop WC, Jeekel J. [The treatment of recurrent inguinal hernia]. Ned Tijdschr Geneeskd 1990;134(11):531-4.
6. Hay JM, Boudet MJ, Fingerhut A, et al. Shouldice inguinal hernia repair in the male adult: the gold standard? A multicenter controlled trial in 1578 patients. Ann Surg 1995;222(6):719-27.
7. IJzermans JN, de Wilt H, Hop WC, Jeekel H. Recurrent inguinal hernia treated by classical hernioplasty. Arch Surg 1991;126(9):1097-100.
8. Janu PG, Sellers KD, Mangiante EC. Mesh inguinal herniorrhaphy: a ten-year review. Am Surg 1997;63(12):1065-9; discussion 9-71.
9. Kux M, Fuchsjager N, Schemper M. Shouldice is superior to Bassini inguinal herniorrhaphy. Am J Surg 1994;168(1):15-8.
10. Paul A, Troidl H, Williams JI, Rixen D, Langen R. Randomized trial of modified Bassini versus Shouldice inguinal hernia repair. The Cologne Hernia Study Group. Br J Surg 1994;81(10):1531-4.
11. Scott NW, McCormack K, Graham P, Go PM, Ross SJ, Grant AM. Open mesh versus non-mesh for repair of femoral and inguinal hernia. Cochrane Database Syst Rev 2002(4):CD002197.
12. Vrijland WW, van den Tol MP, Luijendijk RW, et al. Randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia. Br J Surg 2002;89(3):293-7.
13. de Lange DH, Aufenacker TJ, Roest M, Simmermacher RK, Gouma DJ, Simons MP. Inguinal hernia surgery in The Netherlands: a baseline study before the introduction of the Dutch Guidelines. Hernia 2005;9(2):172-7.
14. Lichtenstein IL, Shulman AG, Amid PK, Montllor MM. The tension-free hernioplasty. Am J Surg 1989;157(2):188-93.
15. Vos PM, Simons MP, Luitse JS, van Geldere D, Koelemaij MJ, Obertop H. Follow-up after inguinal hernia repair. Questionnaire compared with physical examination: a prospective study in 299 patients. Eur J Surg 1998;164(7):533-6.
16. Haapaniemi S, Nilsson E. Recurrence and pain three years after groin hernia repair. Validation of postal questionnaire and selective physical examination as a method of follow-up. Eur J Surg 2002;168(1):22-8.
17. Devereaux PJ BM, Clarke M, Montori VM, Cook DJ, Yusuf S, Sackett DL, Cina CS, Walter SD, Haynes B, Schunemann HJ, Norman GR, Guyatt GH. Need for expertice based randomised clinical trials. BMJ 2005;330:88-93.
18. Liem MS, van Duyn EB, van der Graaf Y, van Vroonhoven TJ. Recurrences after conventional anterior and laparoscopic inguinal hernia repair: a randomized comparison. Ann Surg 2003;237(1):136-41.
19. Bay-Nielsen M, Kehlet H, Strand L, et al. Quality assessment of 26,304 herniorrhaphies in Denmark: a prospective nationwide study. Lancet 2001;358(9288):1124-8.

20. Hair A, Duffy K, McLean J, et al. Groin hernia repair in Scotland. Br J Surg 2000;87(12):1722-6.
21. Nilsson E, Haapaniemi S, Gruber G, Sandblom G. Methods of repair and risk for reoperation in Swedish hernia surgery from 1992 to 1996. Br J Surg 1998;85(12):1686-91.
22. Srinivasan A, Schuricht A. Long-term follow-up of laparoscopic preperitoneal hernia repair in professional athletes. J Laparoendosc Adv Surg Tech A 2002;12(2):101-6.
23. Shulman AG, Amid PK, Lichtenstein IL. The safety of mesh repair for primary inguinal hernias: results of 3,019 operations from five diverse surgical sources. Am Surg 1992;58(4):255-7.
24. Wantz GE. Experience with the tension-free hernioplasty for primary inguinal hernias in men. J Am Coll Surg 1996;183(4):351-6.
25. McGillicuddy JE. Prospective randomized comparison of the Shouldice and Lichtenstein hernia repair procedures. Arch Surg 1998;133(9):974-8.
26. Bringman S, Ramel S, Heikkinen TJ, Englund T, Westman B, Anderberg B. Tension-free inguinal hernia repair: TEP versus mesh-plug versus Lichtenstein: a prospective randomized controlled trial. Ann Surg 2003;237(1):142-7.

Chapter 7

Open or Endoscopic Total Extraperitoneal Inguinal Hernia Repair? A Systematic Review

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Abstract

Background: Although a large number of surgeons currently perform endoscopic hernia surgery using a total extraperitoneal (TEP) approach, reviews published so far are mainly based on trials that compare laparoscopic transabdominal preperitoneal (TAPP) repair with various types of open inguinal hernia repair.
Methods: A qualitative analysis of randomised trials comparing TEP to open mesh or sutured repair was performed.

Results: A total number of 4231 patients was included in the 23 trials used in this current review. Ten out of fifteen trials reported a TEP repair to be associated with an increased duration of surgery compared to open repair. A shorter postoperative hospital stay after TEP repair compared to open repair was reported by six out of eleven trials. In eight out of nine trials, return to work was significantly shorter after TEP repair. Hospital costs were significantly higher for TEP compared to open repair in all four trials in which an economic evaluation was performed. However, total costs, including costs of sick leave, were similar in both groups. Most trials (n = 14) reported no differences in recurrence rates after either TEP or open repair.

Conclusions: Endoscopic total extraperitoneal (TEP) repair is associated with an increased duration of surgery, shorter postoperative hospital stay, earlier return to work and similar recurrence rates compared to open inguinal hernia repair. The procedure involves greater expenses for hospitals, but appears to be cost-effective from a societal perspective.

TEP repair is a serious option for mesh repair of primary hernias.

Introduction

Inguinal hernia repair is one of the most common surgical procedures. In the United States alone, more than 700,000 procedures are performed each year, incurring approximately 2.5 billion dollars of hospital costs[1]. Optimising surgical technique to improve short-term outcome and reduce rate of recurrence is therefore of great value to health care.

During the past 20 years, several hernia repair techniques have been introduced.[2-4] Reduction of rate of recurrence has been the main incentive to develop these new techniques. The introduction of the Lichtenstein tension-free hernioplasty, which employs a mesh to reinforce the abdominal wall, has decreased recurrence rates greatly.[5] Another advantage of the Lichtenstein hernia repair is that it is a relatively straightforward and easy-to-learn procedure that requires minimal dissection and can be performed using local anaesthesia. In addition, since the technique is tension-free, it is associated with a significant reduction in postoperative pain and discomfort compared to conventional open repair.[6] Since the introduction of laparoscopic inguinal hernia repair, most of the ongoing discussion has focused on the choice between either open or endoscopic surgery. Endoscopic inguinal hernia repair is associated with shorter recovery periods, earlier return to daily activities and work and fewer postoperative complications.[7] Some authors suggest that endoscopic repair of recurrent hernia is easier because it is performed in virgin tissue. On the other hand, endoscopic hernia repair requires special skills to overcome limitations inherent to this type of surgery, such as loss of depth perception, a limited range of motion and reduced tactile feedback. As a consequence, it has a significant learning curve[8] and is associated with prolonged operating times.[9] Furthermore, some serious complications have been reported during laparoscopic transabdominal preperitoneal (TAPP) mesh repair,[10-13] some even resulting in the death of a patient.[11,13] Some authors propose that these complications might have been avoided if an endoscopic extraperitoneal approach had been used.[11]

Neumayer et al. described a mixed design of total extraperitoneal (TEP) repair and laparoscopic transabdominal preperitoneal plasty (TAPP) compared with anterior open inguinal repair according to the Lichtenstein method.[14] Randomized clinical trials comparing only total extraperitoneal (TEP) repair with open repair are scarce. Although a lot of surgeons have now adopted the TEP repair, reviews and meta-analyses published so far are primarily based on comparisons between both laparoscopic and endoscopic repair with open inguinal hernia repair.[15] In light of this, a systematic review was conducted of all published and non-published randomized controlled trials comparing TEP with open mesh and suture repair.

Materials and Methods

Randomized trials comparing TEP with open mesh or suture repair were included in this review. Studies that included both TEP and TAPP were not included. Relevant randomized controlled trials were identified through a systematic search of Pubmed, Medline, Embase and Cochrane using the keywords TEP and randomized-controlled-trial. Studies published as abstracts and presented at scientific meetings were also included in the review in order to minimize bias.

Table 1. Details on articles and abstracts regarding randomized controlled trials comparing TEP with open repair

Reference	Type of open repair	Follow-up (months)	No analysed
TEP vs open mesh Heikkinen et al. [16]	Lichtenstein	10 (median)	45
Andersson et al. [17]	Lichtenstein	12 (97%)	168
Merello et al. ¶ [18]	Lichtenstein	"short"	120
Bilgin et al. ¶ [19]	PPOR	12/15 (median)*	60
Lal et al [20]	Lichtenstein	13 (mean)	50
Payne et al. ¶ [21]	Lichtenstein	20 (median)	100
Colak et al. [22]	Lichtenstein	12/11 (mean)*	134
Bostanci et al. [23]	Stoppa	15 (mean)	64
Champault et al. [24]	Stoppa	20 (mean)	100
Champault et al. [25]	Stoppa	20 (mean)	100
Suter et al. [26]	Stoppa	-	39
Suter et al. [27]	Stoppa	-	39
Khoury et al. [28]	Mesh-plug	17 (median)	292
Bringman et al. [29]	Lichtenstein, Mesh-plug	20 (98%)	294
Wright et al. [30]	Lichtenstein, Stoppa	0.25	120
Wright et al. [31]	Lichtenstein, Stoppa	0.25	64
Simmermacher et al. [32]	Ugahary	-	162
TEP vs open non-mesh			
Nathanson et al. ¶ [33]	Shouldice	24 (mean)	184
Bessell et al. [34]	Shouldice, darn	7.3 (mean)	113
Decker et al. [35]	Shouldice	-	30
Fleming et al. [36]	Shouldice	16 (86% median)	231
Champault et al. [37]	Shouldice	12.3 (mean)	181
TEP vs open mixed			
Liem et al. [38]	Procedure of choice	20 (median)	994
Liem et al. [39]	Procedure of choice	1.5	105
Liem et al. [40]	Procedure of choice	20 (median)	237
Liem et al. [41]	Procedure of choice	44 (median)	994
Champault et al. [42]	Shouldice, Stoppa	48 (79% mean)	461
Wright et al. [43]	Lichtenstein, Stoppa & others	60 (mean)	300
Vatansev et al. [44]	Lichtenstein, Bassini, Nyhus	0.25	84

¶ Reported as abstract only
* TEP/open

In total, 23 randomized trials comparing TEP repair to open hernioplasty were identified. In some cases, different outcomes on the same trial were published in separate articles. Therefore, a total number of 29 publications had to be analyzed.[16-44] Of the 23 trials that were included in this review, 18 were reported as full articles and 5 as abstracts only. Most trials compared TEP with one method of open repair. In seven trials, TEP was compared with two or more open types of inguinal hernia repair (Table 1).

Due to heterogeneity between studies (Table I), it was not possible to pool the data. The divergences in trial designs were too great and not all data, needed to perform a quantitative statistical analysis, were available. Therefore, we only performed a qualitative analysis. The current review focuses on operating time, hospital stay, return to work, major complications, recurrence rates and costs of TEP compared to suture repair. Statistical significance was defined as $p < 0.05$.

Results

A total number of 4231 patients was included in the 23 trials analyzed in the current review. Duration of follow-up ranged from 0 to 48 months average.

Table 2. Operating time

Reference	Operating time		P value
	TEP	Open	
Heikinnen et al. [16]	67.5 (40-88)*	53(42-78)*	0.001
Andersson et al. [17]	81 ± 27°	59 ± 20 °	< 0.001
Bilgin et al. [19]	69 (25-150)^	85 (40-150)^	not stated
Lal et al. [20]	75.7 ± 31.6°	54 ± 15°	< 0.001
Colak et al. [22]	49.67 ± 14.11°	56.67 ± 11.67°	0.002
Bostanci et al. [23]	58 (40-85)	35 (20-65)	< 0.05
Suter et al. [26,27]	82 (50-135)^	54 (35-86)^	< 0.001
Khoury et al. [28]	31.5 (5-80)*	30.5 (10-70)*	NS
Bringman et al. [29]	50 (25-150)^	36 (19-88;45 (24-100)^¶	< 0.001‡
Wright et al. [30]	60 (53-72)*	45 (35-52)*	< 0.0001
Liem et al. [38]	45 (35-60)*	40 (30-45)*	< 0.001
Vatansev et al. [44]	58.6 ± 9.7°	54.7 ± 7.2;51.9 ± 6.5; 59.4 ± 8.2¶	NS
Decker et al. [35]	57.2 (38-78)^	53.1 (33-71)^	NS
Fleming et al. [36]	70 (30-145)*	56 (30-145)*	0.0001
Simmermacher et al. [32]	27^	39^	< 0.001

* median (range); ^ mean (range); ° mean ± standard deviation; ¶ Mesh-plug; Lichtenstein; ‡ significant difference between TEP\Lichtenstein versus Mesh-plug;¶ Lichtenstein; Nyhus; Bassini

Operating time

Fifteen trials compared data on duration of operation. TEP repair took significantly longer to perform compared with open methods of inguinal hernia repair in ten of these trials. A reduced operating time for TEP repair compared with Lichtenstein hernioplasty was observed in one trial. For three trials, no significant differences were found. Bilgin et al. mentioned operating times, but did not state whether the differences observed were statistically significant. (Table 2).

Table3. Hospital stay

Reference	Hospital stay		P value
	TEP	Open	
Heikinnen et al. [16]	6.25 h (5.25-21)*	4.75 h (1.75-45)*	< 0.001
Andersson et al. [17]	13.6 ± 6.9 h°	12.4 ± 6.3 h°	NS
Bilgin et al. [19]	1.3 days (1-4)^	3.2 days (1-7)^	not stated
Lal et al. [20]	1.48 days (1-2)^	1.40 days (1-2)^	NS
Colak et al. [22]	1.80 ± 0.65 days^	2.73 ± 1.62 days^	0.001
Champault et al. [24,25]	3.2 days (1-6) ^	7.3 days (5-12)^	0.01
Suter et al. [26,27]	2.2 (2-4)^	2.7 (2-4)^	0.02
Khoury et al. [28]	100% daycare	98% daycare	NS
Wright et al. [30]	1 day (0-1)*	2 days (1-2)*	< 0.0001
Liem et al. [38]	1 day (1-2)*	2 days (1-2)*	< 0.001
Fleming et al. [36]	68% daycare	48% daycare	0.0065

* median (range); ^ mean (range)
° mean ± standard deviation

Hospital stay

In-hospital stay was mentioned in available data on eleven trials. Significant differences in favour of TEP repair were found in six trials. Heikinnen reported an increase in hospital stay after TEP repair compared with Lichtenstein tension-free hernioplasty (6.25h vs 4.75 h; $p < 0.001$).[16] In two trials, no differences between groups were found and in one study, p values were omitted (Table 3).

Major complications

Only one major complication, a bowel obstruction, was reported among the patients undergoing TEP repair within the framework of a randomized trial.[17] In the patients undergoing open surgery, no major complications occurred during or after the surgical procedure.

Table 4. Return to work

Reference	Return to work Open		*P* value
	TEP	Open	
Heikkinen et al. [16]	12 (3-21)*	17 (4-31)*	0.01
Andersson et al. [17]	8 ± 5 °	11 ± 8°	0.003
Merello et al. [18]	11^	26^	not stated
Lal et al. [20]	12.8 ± 7.1°	19.3 ± 4.3°	< 0.001
Champault et al. [24,25]	35 ± 14°	17 ± 11°	0.01
Khoury et al. [28]	8 (5-13)*	15 (11-21)*	< 0.01
Bringman et al. [29]	5 (0-30)*	7 (0-150); 7 (0-70)*¶	0.02‡
Liem et al. [38]	14 (7-21)*	21 (12-33)*	0.001
Fleming et al. [36]	14 (3-42)*	30 (7-84)*	0.0001

* median (range); ° mean ± standard deviation; ¶ Mesh-plug; Lichtenstein; ‡ Significant difference between TEP and Lichtenstein repair only

Return to work

In nine trials, return to work following TEP compared with open repair was studied. For eight of these trials, TEP repair was associated with a significant reduction of workdays lost compared with open repair. (Table 4)

Table 5. Recurrences

Reference	Recurrences		*P* value
	TEP	Open	
Heikinnen et al. [16]	0/22	0/23	NS
Andersson et al. [17]	2/78	0/85	NS
Merello et al. [18]	0/60	0/60	NS
Bilgin et al. [19]	1/30	0/30	NS
Lal et al. [20]	0/25	0/25	NS
Colak et al. [22]	2/67	4/67	NS
Bostanci et al. [23]	0/32	0/32	NS
Champault et al. [24,25]	3/51	1/49	NS
Suter et al. [26,27]	1/20	0/19	NS
Khoury et al. [28]	3/150	4/152	NS
Bringman et al. [29]	2/92	2/104; 0/103¶	NS
Liem et al. [41]	21/487	43/507	0.006
Champault et al. [42]	7/107	8/64; 2/19‡	NS
Wright et al. [43]	3/149	3/151	NS
Fleming et al. [36]	2/93	5/106	NS

¶ Mesh-plug; Lichtenstein; ‡ Shouldice; Stoppa

Recurrence rates

Fifteen trials reported recurrence rates. Liem et al.[41] reported a significantly reduced rate of recurrence following TEP compared with various methods of open mesh and open non-mesh repair (p = 0.006). In the remaining fourteen trials, no significant differences were found (Table 5).

Costs

An economic evaluation was performed in only four trials.[16,17,36,40] In the trial by Heikkinen,[16] hospital costs were significantly increased in totally extraperitoneal endoscopic repair compared to Lichtenstein repair ($1239 vs $782; p < 0.001). Total costs, defined as direct and indirect costs caused by absence of work, were however higher with open repair ($3912 vs $4661 for TEP versus Lichtenstein respectively; p = 0.02). The cost-effectiveness analysis by Andersson[17] showed similar results; an increase in direct costs for TEP compared to Lichtenstein repair ($2085 vs $1480; P < 0.001) but no difference in total costs, including costs of sick leave ($4408 vs $4757; p = 0.21). In the study by Liem,[40] TEP repair was found to involve higher hospital costs (Dfl 2417.24 ($ 1309.13) vs Dfl 1384.91 ($ 750.05)). However, societal costs were lower for endoscopic repair, resulting in total costs that were only Dfl 251, 50 ($ 136.21) higher for TEP repair. Fleming reported an increase of nearly 40 per cent in total costs for TEP repair compared to Shouldice,[36] mainly caused by the high costs of laparoscopic equipment and disposables.

Discussion

Laparoscopic hernia surgery has been criticized because of its complexity, high costs, risk of major complications and the need for general anaesthesia. The majority of randomized trials compare a laparoscopic transabdominal preperitoneal (TAPP) repair with open methods of inguinal hernia repair. As a consequence, systematic reviews and meta-analyses published so far have been primarily based on a comparison between TAPP and open groin hernia repair. Since most surgeons have now adapted the endoscopic extraperitoneal approach, a review of all trials comparing TEP with open mesh and non-mesh repair was performed.

In the present review, most randomized trials reported an increased duration of operation when performing TEP compared with open repair. Possible reasons for these prolonged operative times are the intricacy of the procedure and the need for general anaesthesia.

A major drawback of the laparocopic approach in inguinal hernia repair is the risk of major complications. In total extraperitoneal hernia repair (TEP), the procedure is

performed within the preperitoneal space. The peritoneal space is avoided, presumably leading to a considerable reduction in the risk of major vascular complications, intestinal obstructions and perforations. In the present review, only one major complication was reported among the patients undergoing TEP hernia repair.[17] In this patient, a small bowel obstruction occurred three days after surgery: a loop of the small intestine herniated through a peritoneal tear. These peritoneal defects occur in approximately 10% to 47% of endoscopic hernia repairs.[38,45,46] However, herniation occurs rarely and can be prevented by closing the peritoneal defect, for example, through the use of endoscopic stapling or pretied suture loop ligation.[46]

Proponents of laparosopic inguinal hernia repair often refer to reduced hospital stay and earlier return to daily activities and work associated with this approach. Obviously, hospital stay and return to work are very important outcome measures given that many patients who undergo inguinal hernia repair are of working age. In the present review, the majority of trials showed earlier hospital discharge and quicker return to work after TEP compared with open hernia repair. In a systematic review by the Hernia Trialist Collaboration,[47] which included mainly trials comparing TAPP with open procedures, no significant difference in length of hospital stay was observed between groups ($p = 0.50$). However, return to normal daily activities was found to be earlier following minimally invasive surgery ($p < 0.001$).

The economic benefits to society of reduced absence of work are clearly indicated by the differences in direct and total costs. While in-hospital costs are significantly higher for TEP compared with open hernia repair, no differences exist in total costs, including costs associated with workdays lost. Although endoscopic total extraperitoneal hernia repair is more expensive for hospitals, it appears to be cost-effective for society as a whole. However, long-term recurrence rates and morbidity have not been included in the economic evaluations that have been performed so far.

In a recent meta-analysis of randomized trials comparing open and laparoscopic inguinal hernia repair,[7] a trend was detected towards an increase in the relative probability of short-term hernia recurrence after laparoscopic repair. However, this trend was only found for TAPP compared with open hernia repair and not for trials comparing TEP with open hernia repair. None of the differences observed were statistically significant. In the present analysis of twenty-three trials comparing total extraperitoneal repair to open mesh and sutured repairs, only one trial reported a significant difference in the number of recurrences.[41] In 994 patient undergoing inguinal hernia repair, a reduced recurrence rate after TEP compared to open repair using various techniques was observed (21/507 versus 43/487; $p = 0.006$). None of the other trials showed any significant differences in recurrence rates between the different techniques. A possible reason for this is that these trials were not adequately powered to detect significant variances of this magnitude.

Future large trials might show up such differences, which are not apparent in most of the studies analyzed in the present review.

Neumayer et al. concluded that open technique is superior to the laparoscopic technique for mesh repair of primary hernias comparing both TAPP and TEP repair techniques with the open Lichtenstein method.[14] Laparoscopic total extraperitoneal repair tends to be superior to transabdominal preperitoneal repair, due to lesser morbidity, lower recurrence rates and complications.[48,49]

Endoscopic total extraperitoneal repair seems to be associated with an increased duration of operation, shorter hospital stay and earlier return to work compared to open inguinal hernia repair. (Table 6) Although hospital costs are higher, TEP repair does not seem to produce an increase in total expenses, including costs of sick leave. Recurrence rates after TEP repair seem to be comparable with, if not better than, rates following open methods of repair.

Table 6.

Outcome	**No of trials**	**Significant advantage***	
		TEP	**Open**
Duration of operation	15	10	1
Hospital stay	11	6	1
Return to work	9	7	1
Recurrences	15	1	1 0

* $p < 0.05$

References

1. Rutkow IM, Robbins AW (1993) Demographic, classificatory, and socioeconomic aspects of hernia repair in the United States. Surg Clin North Am 73:413-426.
2. Lichtenstein IL, Shulman AG, Amid PK, Montllor MM (1989) The tension-free hernioplasty. Am J Surg 157:188-193.
3. Welsh DRJ, Alexander MAJ (1993) The Shouldice repair. Surg Clin North Am 73:451-469.
4. Stoppa RE, Warlaumount CK. (1995) The preperitoneal approach and prosthetic repair of groin hernias. In: Nyhus LM, Coldon RE, eds. Hernia, 4th ed. Philadelphia: JB Lippincott 118-210.
5. EU Hernia Trialists Collaboration (2000) Mesh compared with non-mesh methods of open groin hernia repair: systematic review of randomized controlled trials. Br J Surg 87:854-859.
6. Scott NW, McCormack K, Graham P, Go PM, Ross SJ, Grant AM (2002) Open mesh versus non-mesh for repair of femoral and inguinal hernia. Cochrane Database Syst Rev. 4 CD002197
7. Memon MA, Cooper NJ, Memon B, Memon MI, Abrams KR (2003) Meta-analysis of randomized clinical trials comparing open and laparoscopic inguinal hernia repair. Br J Surg 90:1479-1492.
8. Edwards CC 2nd, Bailey RW (2000) Laparoscopic hernia repair: the learning curve. Surg Laparosc Endosc Percutan Tech 10:149-153.
9. Medical Research Council Laparoscopic Groin Hernia Trial Group (2001) Cost-utility analysis of open versus laparoscopic groin hernia repair: results from a multicentre randomized clinical trial. Br J Surg 88:653-661.
10. Tsang S, Normad R, Karlin R (1994) Small bowel obstruction: a morbid complication after laparoscopic herniorraphy. Am Surg 60:332-334.
11. Darzi A, Paraskeva PA, Quereshi A, Menzies-Gow N, Guillou PJ, Monson JR (1994) Laparoscopic herniorraphy: initial experience in 126 patients. J Laparoendosc Surg 4:179-183.
12. Phillips EH, Arregui M, Carroll BJ, Corbitt J, Crafton WB, Fallas MJ, Filipi C, Fitzgibbons RJ, Franklin MJ, McKernan B, et al (1995) Incidence of complications following laparoscopic hernioplasty. Surg Endosc 9:16-21.
13. Kald A, Anderberg B, Smedh K, Karlsson M (1997) Transperitoneal or totally extraperitoneal approach in laparoscopic hernia repair: results of 491 consecutive herniorrhapies. Surg Laparosc Endosc 7: 86-89.
14. Neumayer L, Giobbie-Hurder A, Jonasson O, Fitzgibbons R, Jr., Dunlop D, Gibbs J, Reda D, Henderson W (2004) Open mesh versus laparoscopic mesh repair of inguinal hernia. N Engl J Med 350:1819-1827.
15. Bittner R, Sauerland S, Schmedt CG (2005) Comparison of endoscopic techniques vs Shouldice and other open nonmesh techniques for inguinal hernia repair: a meta-analysis of randomized controlled trials. Surg Endosc 19:605-615.
16. Heikkinen TJ, Haukipuro K, Koivukangas P, Hulkko A (1998) A prospective randomized outcome and cost comparison of totally extraperitoneal endoscopic hernioplasty versus lichtenstein hernia operation among employed patients. Surg Laparosc Endosc 8:338-344.
17. Andersson B, Hallén M, Leveau P, Bergenfelz A, Westerdahl J (2003) Laparoscopic extraperitoneal inguinal hernia repair versus open mesh repair: A prospective randomized controlled trial. Surgery 133:464-472.

18. Merello J, Guerra GA, Madriz J, Guerra GG (1997) Laparoscopic TEP versus open Lichtenstein hernia repair. Randomized trial. Surg Endosc 11:545.
19. Bilgin B, Özmen MM, Zülfikaroglu B, Cete M, Hengirmen S (1997) Totally extraperitoneal (TEP) hernia repair preperitoneal open repair (PPOR). Surg Endosc 11:542.
20. Lal P, Kajla RK, Chander J, Saha R, Ramteke VK (2003) Randomized controlled study of laparoscopic total extraperitoneal vs open Lichtenstein inguinal hernia repair. Surg Endosc 17:850-856.
21. Payne J, Izawa M, Glen P (1996) Laparoscopic or tension-free inguinal hernia repair? A cost benefit analysis of 200 prospective randomized patients. SAGES, Philadelphia.
22. Colak T, Akca T, Kanik A, Aydin S (2003) Randomized clinical trial comparing laparoscopic totally extraperitoneal approach with open mesh repair in inguinal hernia. Surg Laparosc Endosc Percutan Tech 13:191-195.
23. Bostanci BE, Tetik C, Özer S, Özden A (1998) Posterior approaches in groin hernia repair: open or closed. Acta Chir belg 98:241-244.
24. Champault G, Rizk N, Catheline JM, Riskalla H, Boutelier P (1996) Hernies de l'aine. Traitment laparoscopique pré-péritoneal versus opération de Stoppa. Etude randomisée: 100 cas. J Chir 133:274-280.
25. Champault GG, Rizk N, Catheline JM, Turner R, Boutelier P (1997) Inguinal hernia repair. Totally preperitoneal laparoscopic approach versus stoppa operation: randomized trial of 100 cases. Surg Laparosc Endosc 7:445-450.
26. Suter M, Martinet O (2002) Postoperative pulmonary dysfunction after bilateral inguinal hernia repair: a prospective randomized study comparing the Stopa procedure with laparoscopic total extraperitoneal repair (TEPP). Surg Laparosc Endosc Percutan Tech 12:420-425
27. Suter M, Martinet O, Spertini F (2002) reduced acute phase response after laparoscopic total extraperitoneal bilateral hernia repair compared to open repair with the Stoppa procedure Surg Endosc 16:1214-1219.
28. Khoury N. (1998) A randomized prospective controlled trial of laparoscopic extraperitoneal hernia repair and mesh-plug hernioplasty: a study of 315 cases. J Laparoendosc Adv Surg Tech 8:367-372.
29. Bringman S, Ramel S, Heikkinen TJ, Englund T, Westman B, Anderberg B (2003) Tension-free inguinal hernia repair: TEP versus mesh-plug versus lichtenstein. Ann Surg 237:142-147.
30. Wright DM, Kennedy A, Baxter JN, Fullarton GM, Fife LM, Sunderland GT, O'Dwyer PJ (1996) Early outcome after open versus extraperitoneal endoscopic tension-free hernioplasty: a randomized clinical trial. Surgery 119:552-557
31. Wright DM, Hall MG, Paterson CR, O'Dwyer PJ (1999) A randomized comparison of driver reaction time after open and endoscopic tension-free inguinal hernia repair. Surg Endosc 13:332-334.
32. Simmermacher RK, Van Duyn EB, Clevers GJ, de Vries LS, van Vroonhoven TJMV (2000) Preperitoneal mesh in groin hernia surgery. A randomized trial emphasizing the surgical aspects of preperitoneal placement via a laparoscopic (TEP) or Grid-iron (Ugahary) approach. Hernia 4:296-298.
33. Nathanson L, Adib R. (1996) Randomized trial of open and laparoscopic inguinal hernia repair. Surg Endosc 10:192.
34. Bessell JR, Baxter P, Riddell P, Watkin S, Maddern GJ (1996) A randomized controlled trial of laparoscopic hernia repair. Surg Endosc 10:495-500.
35. Decker D, Lindemann C, Springer W, Low A, Hirner A, von Ruecker A (1998) Endoscopic vs conventional hernia repair from an immunologic point of view. Surg Endosc 13:335-339.
36. Fleming WR, Elliott TB, Jones RM, Hardy KJ (2001) Randomized clinical trial comparing totally extraperitoneal inguinal hernia repair with the Shouldice technique. Br J Surg 88:1183-1188.

37. Champault G, Benoit J, Lauroy J, Rizk N, Boutelier P (1994) Hernies de l'aine de l'adulte. Chirurgie laparoscopique vs opération de Shouldice. Étude randomisée controlée : 181 patients. Résultats préliminaires. Ann Chir 48:1003-1008.
38. Liem MS, van der Graaf Y, van Steensel CJ, Boelhouwer RU, Clevers GJ, Meijer WS, Stassen LP, Vente JP, Weidema WF, Schrijvers AJ, van Vroonhoven TJ (1997) Comparison of conventional anterior surgery and laparoscopic surgery for inguinal-hernia repair. N Engl J Med 336:1541-1547.
39. Liem MS, van der Graaf Y, Zwart RC, Geurts I, van Vroonhoven TJ (1997) A randomized comparison of physical performance following laparoscopic and open inguinal hernia repair. Br J Surg 84:64-67.
40. Liem MSL, Halsema JAM, van der Graaf Y, Schrijvers AJ, van Vroonhoven TJ (1997) Cost-effectiveness of extraperitoneal laparoscopic inguinal hernia repair: a randomized comparison with conventional herniorrhaphy. Ann Surg 6:668-676.
41. Liem MSL, van Duyn EB, van der Graaf Y, van Vroonhoven TJ (2003) Recurrences after conventional anterior and laparoscopic inguinal hernia repair. A randomized comparison. Ann Surg 237:136-141.
42. Champault G, Barrat C, Catheline JM, Rizk, N (1998) Hernies de l'aine. Résultats à 4 ans de deux études prospectives randomisées comparant les opérations de Shouldice et de Stoppa à l'abord laparoscopique totalement pré-péritonéal (461 patients). Ann Chir 52:132-136.
43. Wright D, Paterson C, Scott N, Hair A, O'Dwyer PJ (2002) Five-year follow-up of patients undergoing laparoscopic or open groin hernia repair. A randomized controlled trial. Ann Surg 235:333-337.
44. Vatansev C, Belviranli M, Aksoy F, Tuncer S, Sahin M, Karahan O (2002) The effects of different hernia repair methods on postoperative pain medication and CRP levels. Surg Laparosc Endosc Percutan Tech 12:243-246.
45. Knook MTT, Weidema WF, Stassen LPS, van Steensel CJ (1999) Endoscopic total extraperitoneal repair of primary and recurrent inguinal hernias. Surg Endosc 13:507-511.
46. Lau H, Patil NG, Yuen WK, Lee F (2002) Management of peritoneal tear during endoscopic extraperitoneal inguinal hernioplasty. Surg Endosc 16:1474-1477.
47. Collaboration EH. (2000) Laparoscopic compared with open methods of groin hernia repair: systematic review of randomized controlled trials. Br J Surg 87:860-867.
48. Leibl BJ, Jager C, Kraft B, Kraft K, Schwarz J, Ulrich M, Bittner R (2005) Laparoscopic hernia repair-TAPP or/and TEP? Langenbecks Arch Surg 2005 390:77-82.
49. The MRC Laparoscopic Groin Hernia Trial Group. (1999) Laparoscopic versus open repair of groin hernia: a randomised comparison. Lancet 354:185-190.

Chapter 8

10 Year Follow-Up of Endoscopic Total Extraperitoneal Repair of Primary and Recurrent Inguinal Hernia

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Abstract

Background: Follow-up of recurrence rates after 10 years needs to be assessed to determine whether endoscopic repair is favourable in the long term.

Methods: Between January 1995 and January 1996, 306 consecutive patients underwent TEP inguinal hernia repair. Long-term follow-up occurred from January 2006 till May 2006.

Results: After 10 year follow-up, six (4%) recurrences were found in the primary inguinal hernia group and three recurrences (11%) in the recurrent inguinal hernia group.
There was no significant correlation age, experience, hospital stay and operating time with recurrences.

Conclusions: long-term results of TEP primary inguinal hernia demonstrate that it is an effective and safe procedure with a acceptable rate of recurrences. Recurrence rates may be underestimated as we found that recurrences continue to occur op to ten years.

Introduction

Groin hernia repair is the most frequently performed operation in general surgery. Approximately 800.000 repairs are performed in the USA and 33.000 in The Netherlands annually, incurring approximately 2.5 billion dollars of hospital costs.[1,2] Optimising surgical technique to improve long-term outcome and reduce rate of recurrence would have a significant medical and economical impact.[3]

Endoscopic inguinal hernia repair is associated with shorter recovery periods, earlier return to daily activities and work and fewer postoperative complications.[4] Some authors suggest that endoscopic repair of recurrent hernia after anterior hernia repair is easier because it is performed in virgin tissue. On the other hand, endoscopic hernia repair requires special skills to overcome limitations inherent to this type of surgery, such as loss of depth perception, a limited range of motion and reduced tactile feedback. As a consequence, it has a significant learning curve and is associated with prolonged operating times.[5-7]

During the past 20 years, several hernia repair techniques have been introduced**.** Reduction of rate of recurrence has been the main incentive to develop these new techniques. Data on long-term rates of recurrence in total endoscopic preperitoneal (TEP) inguinal hernia repair are hardly available.[8] Follow-up of recurrence rates after 10 years needs to be assessed to determine whether endoscopic repair is favourable in the long term.

The purpose of this prospective study was to provide long-term results and to evaluate long-term recurrences in TEP inguinal hernia repairs.

Patients and Methods

Between January 1995 and January 1996, 306 consecutive patients underwent an elective TEP repair in the Ikazia Hospital Rotterdam, The Netherlands. A polypropylene prosthetic mesh placement (10 x 15 cm) was performed as described before.[5,9] The prosthesis (Marlex® (C.R. Bard, Billerica, Massachusetts, USA) is anchored to the abdominal wall by intraabdominal pressure; no fixation materials were used. All procedures were under general anesthesia.

Bilateral inguinal hernias were excluded from this study, because different techniques were used for correction.

Primary and recurrent hernia repairs were analysed separately. In all cases of recurrent hernia, the hernia occurred after prior conventional, anterior repair. All operations were performed under supervision of 3 staff surgeons who were experienced in endoscopic surgery.

Gender, age, type of hernia, performed by surgeon or resident, perioperative complications, operating time, postoperative complications, and hospital stay were assessed. Classification of inguinal hernia occurred according to Nyhus criteria.[10] Operation time was defined as the time from first incision to last suture. Length of hospital stay (i.e., number of days in hospital including day of surgery) was assessed.

Follow-up with physical examination was performed at the outpatient clinic within 2 weeks. Long-term follow-up occurred from January 2006 till May 2006. Patients were invited to visit the outpatient clinic, where patient history was taken and physical examination was performed. All medical records were reviewed for evidence of recurrences.The physical examination was done by one of the authors who did not perform the initial hernia repair.

The groin region was examined physically for recurrence of inguinal hernia, which was defined as a symptomatic or asymptomatic defect (bulge or weakness) in the abdominal wall of the operative area with herniation of abdominal contents outside the external ring, exacerbated by Valsalva manoeuvre. Ultrasound examination was performed when physical examination was not conclusive.

If the patients had not replied after a second mailing, they were contacted by telephone, and visited at home if they agreed. The general practitioner was consulted when phone numbers were unknown or false. Finally a search engine on the internet was used to find the right phone number of the patient.

A chi-square test was performed to evaluate recurrences after TEP inguinal hernia repair. Means of baseline characteristics were compared using an unpaired t-test. A p-value of 0.05 (two-sided) was considered the limit of significance. All statistical analyses were performed using Statistical Package for Social Sciences for Windows (SPSS Inc., Chicago, Illinois. U.S.A.).

Results

Of 306 TEP repairs performed in 1995, 49 (16%) patients were lost to follow-up, 36 patients (12%) deceased within the long-term follow-up period. The causes of death were unrelated to the performed TEP inguinal hernia repair. Partially because of a migrating population 12 patients (4%) could not visit the outpatient clinic and 31 patients (10%) did not want to cooperated in the study.

Twenty three bilaterally performed TEP inguinal hernia repairs were excluded from this study. Of the 178 remaining patients,150 were operated unilaterally for a primary inguinal hernia and 28 were operated for a recurrent inguinal hernia after conventional hernia repair (Figure 1).

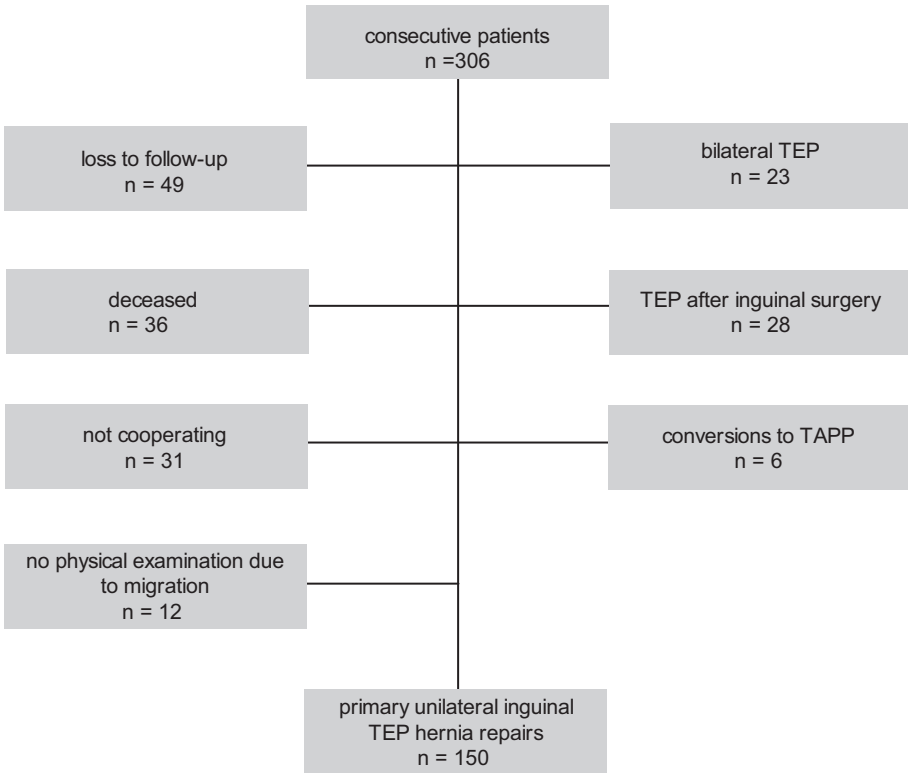

Figure 1. Flow chart

Table 1. Characteristics primary inguinal hernia after 10 year follow-up

	Recurrence (n = 6)			Non-recurrence (n = 144)		
Men (%)	6	(100)		137	(95)	
Age (years): median (range)	67.5	(48-72)		54	(21-86)	
Hospital stay (days): median (range)	2	(2-3)		2	(1-10)	
Time in OR (min): median (range)*	45	(30-75)		30	(15-120)	
Staff surgeon (%)	5	(83)		119	(83)	
Senior resident (%)	1	(17)		25	(17)	
Loyd Nyhus classification (%)**	2	0	4	74	22	37
2, 3a, 3b	(33%)	(0%)	(67%)	(51%)	(15%)	(26%)

* Time in operating room, measured from first incision till closure of the skin

** 11 (8%) Lloyd Nyhus classifications are missing in the operation report of the non-recurrence group

Primary inguinal hernia

After 10 year follow-up, six (4%) recurrences were found (Table1).

Of these six recurrences, three developed within the first two years after operation. One patient was without complains when examined, one suffered from groin pain at follow-up and one was about to have an elective procedure for a recurrent hernia inguinalis.

Three staff surgeons performed 83% of the operations; 17% of operations were performed by senior residents under supervision of one of the three surgeons. No significant correlation were found between surgeons and residents with the number of recurrences.

No significant correlations were found between age, hospital stay and operating time with recurrences.

Table 2. Characteristics TEP repair for recurrent inguinal hernia after 10 year follow-up

	Recurrence (n = 3)		**Non-recurrence (n = 25)**	
Men (%)	3	(100)	21	(84)
Age (years): median (range)	48	(47-67)	56	(25-73)
Hospital stay (days): median (range)	2	(1-2)	2	(1-3)
Time in OR (min): median (range)*	60	(30-75)	40	(16-90)
Staff surgeon (%)	1	(33)	19	(76)
Senior resident (%)	2	(67)	6	(24)

*Time in operating room, measured from first incision till closure of the skin

Recurrent inguinal hernia

A total of 28 patients were operated for a recurrent hernia after conventional inguinal hernia repair. Three patients (11%) were diagnosed with a re-recurrence after TEP inguinal hernia repair (Table 2).

All three recurrences occurred more then five years after operation. Two were found during physical examination and were without complains. One was operated nine years after operation. No significant correlations were found between age, experience, hospital stay and operating time with recurrences.

Discussion

Retrospective and prospective studies on the results of endo-/laparoscopic inguinal hernia repair, including bilateral repair, go back to 1994 describing a 0 to 10.1 per cent recurrence rate at follow-up.

From the majority of reported studies it does not become clear which fraction of patients underwent physical examination in order to determine hernia recurrence. It is well known that the reported recurrence rates are influenced not only by surgical expertise and method of repair, but also by the length and method of follow-up.[11] With a physical examination in all of the remaining patients after a follow-up period of 10 years, the results of this study are most likely close to reality.[11]

In september 1992 one staff surgeon performed the fist hernia repair laparoscopicly by the transabdominal preperitoneal plasty (TAPP) in our hospital. In march 1993 the first TEP repair was performed by the same surgeon. This technique was taught to three other staff surgeons who also performed all TEP repairs described in this study. 306 consecutive patients were included in this study after a two year learning curve.

Long term follow-up remains difficult to obtain as many patients undergoing hernia repair, a benign disease, are lost to follow-up, do not show up or have deceased.[9,12] The high number lost to follow-up may have an influence on the outcome. Although time-consuming and incomplete our data indicate that long-term follow-up is of great importance for research regarding inguinal hernia repair.

An important new finding in this study is that recurrences of inguinal hernia continue to occur up to 10 years after endoscopic hernia repair. In a small number of patients in this study operated endoscopicly after previous conventional hernia repair, all recurrences occurred after 5 years. It is therefore likely that recurrence rates of endoscopic techniques are generally underestimated, because most studies are either not prospective or do not include long-term follow-up.

In a recent systematic review, one trial reported a significant difference in the number of recurrences in favour of TEP repair compared with anterior inguinal hernia repair techniques.[13] Neumayer et al. concluded that open mesh technique is superior to the laparoscopic technique for mesh repair of primary hernias concerning recurrence rates, comparing both TAPP and TEP repair techniques (recurrence rate 10.1%) with the open Lichtenstein method (recurrence rate 4.9%).[5] Irving L. Lichtenstein et al. established the basis for current inguinal hernia surgery and reported 1000 consecutive patients with primary mesh repair followed-up from 1 year to 5 years without recurrences.[14] A recent prospective long-term follow-up study claims a recurrence rate of 1% after Lichtenstein inguinal hernia repair.[15] These excellent outcomes established the Lichtenstein tension-free hernioplasty as the gold standard for primary inguinal hernia surgery in The

Netherlands. Future long-term follow-up randomized trials comparing Lichtenstein inguinal hernia repair with TEP repair are needed to determine the exact difference in recurrence rate.

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References

1. Rutkow IM. Demographic and socioeconomic aspects of hernia repair in the United States in 2003. Surg Clin North Am 2003;83(5):1045-51, v-vi.
2. www.prismant.nl. National Medical Registration 2004.
3. Simons MP, Kleijnen J, van Geldere D, Hoitsma HF, Obertop H. Role of the Shouldice technique in inguinal hernia repair: a systematic review of controlled trials and a meta-analysis. Br J Surg 1996;83(6):734-8.
4. Memon MA, Cooper NJ, Memon B, Memon MI, Abrams KR. Meta-analysis of randomized clinical trials comparing open and laparoscopic inguinal hernia repair. Br J Surg 2003;90(12):1479-92.
5. Neumayer L, Giobbie-Hurder A, Jonasson O, et al. Open mesh versus laparoscopic mesh repair of inguinal hernia. N Engl J Med 2004;350(18):1819-27.
6. Edwards CC, 2nd, Bailey RW. Laparoscopic hernia repair: the learning curve. Surg Laparosc Endosc Percutan Tech 2000;10(3):149-53.
7. Cost-utility analysis of open versus laparoscopic groin hernia repair: results from a multicentre randomized clinical trial. Br J Surg 2001;88(5):653-61.
8. Scott NW, McCormack K, Graham P, Go PM, Ross SJ, Grant AM. Open mesh versus non-mesh for repair of femoral and inguinal hernia. Cochrane Database Syst Rev 2002(4):CD002197.
9. Liem MS, van Duyn EB, van der Graaf Y, van Vroonhoven TJ. Recurrences after conventional anterior and laparoscopic inguinal hernia repair: a randomized comparison. Ann Surg 2003;237(1):136-41.
10. Nyhus LM. Individualization of hernia repair: a new era. Surgery 1993;114(1):1-2.
11. Paul A, Troidl H, Williams JI, Rixen D, Langen R. Randomized trial of modified Bassini versus Shouldice inguinal hernia repair. The Cologne Hernia Study Group. Br J Surg 1994;81(10):1531-4.
12. Kux M, Fuchsjager N, Schemper M. Shouldice is superior to Bassini inguinal herniorrhaphy. Am J Surg 1994;168(1):15-8.
13. Kuhry E, van Veen RN, Langeveld HR, Steyerberg EW, Jeekel J, Bonjer HJ. Open or endoscopic total extraperitoneal inguinal hernia repair? A systematic review. Surg Endosc 2007;21(2):161-6.
14. Lichtenstein IL, Shulman AG, Amid PK, Montllor MM. The tension-free hernioplasty. Am J Surg 1989;157(2):188-93.
15. van Veen RN, Wijsmuller AR, Vrijland WW, Hop WC, Lange JF, Jeekel J. Long-term follow-up of a randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia. Br J Surg 2007;94(4):506-10.

Chapter 9

Successful Endoscopic Treatment of Chronic Groin Pain in Athletes

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Abstract

Background: Chronic groin pain, especially in professional sportsmen, is a difficult clinical problem.

Methods: From January 1999 to August 2005, 55 professional and semiprofessional sportsmen (53 males; mean age, 25 ± 4.5 years; range, 17–36 years) with undiagnosed chronic groin pain were followed prospectively.

All patients underwent an endoscopic total extraperitoneal (TEP) mesh placement.

Results: Incipient hernia was diagnosed in the study athletes: 15 on the right side (27%), 12 on the left side (22%), and 9 bilaterally (16%). In 20 patients (36%), an inguinal hernia was found: 3 direct inguinal hernias (5%) and 17 indirect hernias (31%). All the athletes returned to their normal sports level within 3 months after the operation.

Conclusion: A TEP repair must be proposed to patients with prolonged groin pain unresponsive to conservative treatment. If no clear pathology is identified, reinforcement of the wall using a mesh offers good clinical results for athletes with idiopathic groin pain.

Introduction

Chronic exercise-related groin pain can be a debilitating condition, particularly in athletes. Gilmore's groin, incipient hernia, athletic pubalgia, sports hernia, sportsman's hernia, groin disruption or conjoint tendon injury can best be described as incompetent abdominal wall musculature in the absence of a clinically detectable hernia (bulge).[1, 2-2,3] It is a common cause of chronic groin pain in athletes, together with osteitis pubis, stress injury involving the pubic bones, intra-articular hip abnormality, urological diseases, nerve entrapment, and origin lesions of the adductor muscle.[2,4-6] Chronic groin pain in athletes is a well-recognized and problematic entity. Sports which require repetitive kicking, evasive or side-to-side motion, and physical contact seem to be more commonly affected by this condition.[5,7] Among professional sportsmen it has an estimated incidence of 0.5 per cent to 6.2 per cent, and is particularly common in soccer and hockey players.[7-13] Renström and Peterson reported that 5 per cent of all soccer injuries are localized to the groin region and 5 per cent of patients attending sports clinics have groin symptoms.[1,14-17]

Chronic groin pain can result in significant reduction in playing time.[4,9,10,18] The number of sports-related injuries have increased as a function of increased athletic activities and the demand for an early return to normal sports activities puts pressure on the doctor for immediate diagnosis and treatment.[11,19] Because of the lengthy differential of diagnostic possibilities and implicit a degree of overlap of symptoms with other clinical entities, it's difficult to determine the diagnosis. (Table 1)[4,2,11,14,20-24]

Table 1. Differential diagnoses of groin pain in athletes

Muscle strain	Inguinal or femoral hernia
Adductor tendonitis	Lymphadenopathy
Avascular necrosis of femoral head	Ovarian cyst
Bursitis	Pelvic inflammatory disease
Stress fractures	Postpartum symphysis separation
Sportman's hernia	Prostatitis
Hockey player's syndrome	Sacroiliac joint problems
Osteitis Pubis	Lumbar spine pathology
Pubic instability	Urinary tract infection
Connective tissue disease	Acetabular disorders
Conjoined tendon dehiscence	Snapping hip syndrome
Herniated nucleus pulposus	Intra abdominal inflammation
Myositis ossificans	Diverticular disease
Nerve entrapment	Abdominal aortic aneurysm
Osteoarthritis	Epididymitis
Seronegative spondyloarthropathy	Hydrocele/varicocele
Slipped capital femoral epiphysis	Testicular neoplasm
Legg-Calvé-perthes disease	Testicular torsion
Spinal or hip abnormalities, hip joint changes	

Determining the exact cause of the pain may prove quite elusive due to the lengthly differential of diagnostic possibilities [2,11,14, 20-24]

Clinically, sportman's hernia is characterized by insidious-onset, gradually worsening, diffuse groin pain. It may radiate along the inguinal ligament, perineum and rectus muscles. Radiation of pain across the midline, down the inside of the thigh into the adductor area, into the scrotum and testicles is present in about 30 per cent of symptomatic patients.[1,20,25]

Giving support to the theory that posterior weakness is the prime cause of groin pain in athletes, a mesh is placed resolving the problem of the posterior weakness in the inguinal wall.[2,21]

The present prospective study was designed to determine specific findings in athletes who are diagnosed with a sportsman's hernia and to evaluate the effectiveness of endoscopic, total extraperitoneal (TEP) repair.

Materials and Methods

A total of thirty-eight (69%) professional and seventeen (31%) semiprofessional athletes with undiagnosed chronic groin pain were referred to the Erasmus Medical Center Rotterdam, The Netherlands by their team physicians. These fifty-five sportsmen (53 male, 25 ± 4.5 year, range, 17-36) were followed prospectively from January 1999 to August 2005. The group consisted of forty-seven (85%) soccer players, two triathletes, one running athlete, one tennis player, one bike racer, one baseball player, and one speed ice skater. All patients had undiagnosed chronic groin pain related to sports activities. The pain existed for at least 3 months and did not respond to conservative therapy like prolonged rest, physiotherapy and adequate pain medication. Pain characteristics of patients as well as physical exam findings were scored (Table 2).

Table 2. Pain characteristics and findings at physical examination of patients diagnosed with a sportman's hernia

	Total n = 55	
Insidious onset (%)*	38	(69%)
Local tenderness over conjoined tendon and inguinal canal (%)	48	(88%)
Radiate to adductor region (%)	20	(36%)
Aggravated by sudden movements (%)	29	(53%)
Exacerbated by coughing or sneezing (%)	21	(38%)
Resistant to conservative treatment (%)	55	(100%)
Tenderness by palpation	39	(71%)
Tenderness exacerbated by resisted sit-up (%)	20	(36%)
Local swelling	2	(4%)
Dilated superficial inguinal ring (%)	7	(13%)
Signs similar to osteitis pubis and adductor tenodonopathy (%)	7	(13%)

*Diffuse groin pain is gradually worsening in time.

Various imaging modalities were used to identify hernias and exclude other pathology. Additional to other imaging modalities, which were performed outside our clinic, we performed ultrasonographies, bone scans, radiographs of the pelvis and magnetic resonance imaging (MRI) scans. (Table 3).

Table 3. Imaging modalities

	Total n = 55		Findings
Ultrasonography (%)	29	(53%)	Inguinal hernia (6) Adductor muscle tedinitis (5)
Bone scans (%)	15	(27%)	Osteitis pubis (2)
Radiograps of the pelvis (%)	28	(51%)	None
MRI scans (%)*	8	(15%)	None

* performed additional to ultrasonography

Radiographs of the pelvis were performed in all patients with limited function tests, bone scans in patients with (active) stress pain of the adductor muscles and ultrasonograpy in patients with signs of adductor tendonitis or when there was any doubt concerning the existence of a lateral hernia. In case of insufficient view with ultrasonograpy a MRI scan was performed additionally.

All patients underwent an endoscopic total extraperitoneal (TEP) mesh placement (10x15 cm Prolene™, Johnson & Johnson) after reduction of a possible hernia as described before.[26,27] Fixation of the mesh with staplers was only performed during bilateral corrections. All procedures were under general anesthesia.

Follow-up

All patients were seen by the one general surgeon (C. v. E)* and one orthopaedic surgeon (M.H.)* in the outpatient clinic 3 weeks after the operation. These surgeons are specialized in sports injuries, has diagnosed all patients preoperatively. The TEP repair in all atheletes was performed by two experienced surgeons (G.K. and H.B.)*. All patients received a rehabilitation schedule postoperatively, which contains a specific training program under supervision of their team physiotherpist (Table 4).

Table 4. Rehabilitation schedule

Time	Purpose	Therapy
Week 0-1	Wound recovery Pain management	Walking 5 km/h
Week 1-2	Optimizing scar tissue Preventing muscle atrophia	Aqua training "Power"-walking[a] Cycle ergometer[b] Isometric training rectus abdominis muscle Steps[c]
Week 2-3	Dynamic training rectus abdominis muscle Functional exercises	Sit-ups Running[d] Lunges
Week 3-5	Sport specific training	Weight training Normal training[e]
Week 6	Normal training	

[a] Starting with 20 minutes, adding 5 minutes until a maximum of 50 minutes
[b] Starting with 4 times 10 minutes until a maximum of15 minutes (2 minute break, 80-90 RPM)
[c] Leg in 60 degrees anteflexion
[d] Speed and interval training
[e] Within pain free limit

The team physician of the patient was contacted by telephone 3 months after the operation. The main result of this contact was to determine the time to return to normal sportsactivities.

Statistical analysis

A chi-square test was performed to compare occurrence of postoperative pain between patients with and without a detectable inguinal hernia during TEP. Means of baseline characteristics were compared using an unpaired t-test. A p-value of 0.05 (two-sided) was considered the limit of significance. All statistical analyses were performed using Statistical Package for Social Sciences for Windows (SPSS Inc., Chicago, Illinois. U.S.A.).

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*M.H.: Maarten Heijboer
*G.K.:Geert Kazemier
*H.B.: Jaap Bonjer

Results

All patients had persistent groin pain during sports activities. Pain was unilaterally in forty-two (76%) patients and bilaterally in thirteen (24%) patients. In the majority of patients (85%) pain disappeared within hours of ceasing vigorous activity; in 15% pain was continuously present. In Twenty-five patients (45%) groin pain existed longer than 6 months. Pain was mostly located near the superficial annulus of the inguinal canal (88%) or at the insertion of the rectus abdominis muscle on the pubis (12%). Pain with coughing, sneezing, or Valsalva maneuvers was present in twenty-one (38%) patients.
On physical examination, local tenderness by palpation was found in thirty-nine (71%) patients. Two patients had local swelling in the groin. While stretching the adductor muscles actively, twenty patients (36%) complained about pain in the groin area.

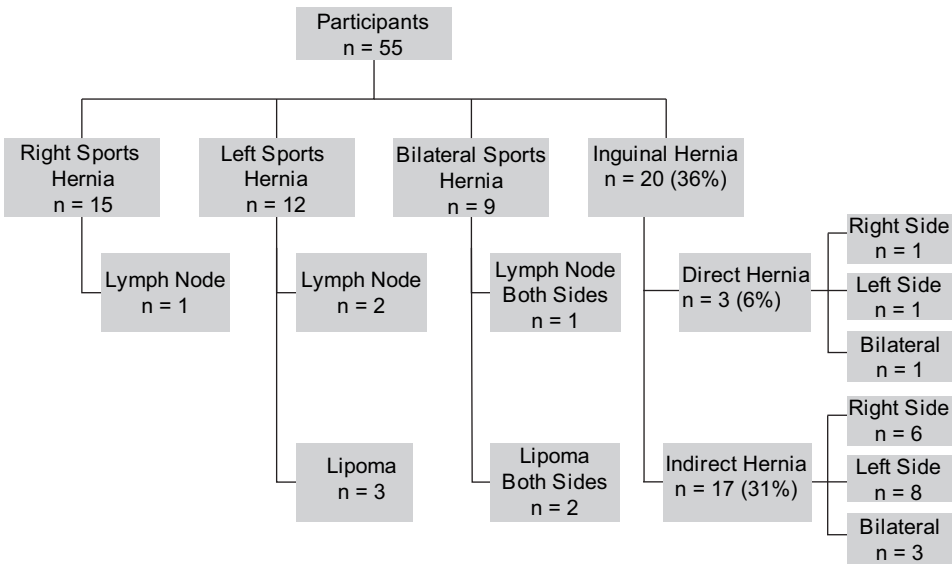

Figure1. Flowchart describing the number of participants and findings during TEP repair

Twenty-nine ultrasonographies were performed and eleven (38%) showed pathology (6 inguinal hernias, 5 adductor muscle tendinitis). Osteitis pubis was diagnosed in two patients (13%) of the fifteen performed bone scans. No pathology was diagnosed by either a X-ray of the pelvis (28) or an MRI scan (8) (Table 3).

Fifty-six TEP repairs were performed on fifty-five patients; one patient was operated unilaterally twice. Fixation of the mesh occurred by transabdominal pressure in fifty-two (93%) operations. In four bilateral hernia corrections (7%) the meshes were fixated with staples.

Adductor tenotomy was performed 3 times unilaterally and 1 time bilaterally additional to the TEP repair with good results.

During the procedure the incipient hernia or sportsman's hernia was diagnosed 15 (27%) times at the right side, 12 (22%) at the left side, 9 (16%) times bilaterally. In 9 cases a possible cause of chronic groin pain was diagnosed; 4 lipomas and 5 lymph nodes were found near the internal ring during endoscopy.

In 20 (36%) patients an inguinal hernia was found of which 3 (5%) were direct inguinal hernias and 17 (31%) indirect hernias according to the Nyhus classification. (Figure 1).

No significant differences in complaints of groin pain during follow-up were observed between the presence and the absence of an inguinal hernia during operation (Chi-square test).

All wounds healed within 3 weeks after surgery. Forty-eight (88%) patients returned to normal sports activities within 6 to 8 weeks, without groin pain. One patient (a professional tennis player) complained about persisting pain 6 weeks after operation. Ultrasonography showed seroma under the mesh. Drainage of this seroma was successful. Five (9%) patients (4 soccer players and 1 triathlete) were unable to sport on their desired level after 12 weeks because of resistant pain in the groin region, which was solved by physiotherapy and rest. Two patients (both soccer players) suffered from a second episode of stretch pain of the adductor muscles unilaterally after a pain free period of respectively four and six months. In both players a rupture of the adductor longus muscle was diagnosed with ultrasonography which was treated conservatively.

Discussion

This is the first paper in the literature describing the results of an endoscopic procedure. Exclusively among professional athletes experiencing groin pain for a longer period.

For athletes with chronic groin pain imaging modalities should include a careful history and physical examination if no clear diagnosis can be made. However, a group of patients with undiagnosed groin pain remains after consecutively performing X-rays of the pelvis and hips, bone scintigraphy, and ultrasonography of the groin region. Among athletes a symptomatic, not-palpable hernia has been described with various incidences of 36 per cent to 90 per cent.[8] Clinically undetectable deficiency of the posterior inguinal wall is the most commonest operative finding in patients with groin pain.[6,8,11,20,28] In the cited studies discrete preoperative parameters of inguinal wall insufficiency have not been reported.

Weakening of the transversalis fascia, tears in the internal oblique muscles, disruption of the groin with a torn external oblique aponeurosis causing dilatation of the superficial inguinal ring, and dehiscence between the torn conjoined tendon and the inguinal

ligament, constitute the groin injury.[1,3,7,10,29] This diverse spectrum of injury reflects the unknown etiology. Despite a diverse etiology of chronic groin pain in athletes, most authors agree that herniorraphy (TEP) produces good results.[1,15]

All efforts should be focused on identifying the aetiology of chronic groin pain before referring a patient for operation. Despite advances in ultrasound imaging and other diagnostic tools, the diagnosis is missed in a high number of patients.[30] In our series, 29 ultrasonographies were performed in which 5 inguinal hernias were diagnosed. Of the 5 diagnosed inguinal hernias with ultrasonography 3 were false-positive and 2 were proved to be indirect hernias during operation (TEP). Neither X-rays of the pelvis and hip (29) nor MRI scans (9) showed pathology. Of 9 performed MRI scans 3 were false-negative and proved to be indirect hernias during operation. Osteitis pubis was diagnosed 2 times with bone scintigraphy (16). The present patients had often undergone plain radiography of the pelvis and hips, ultrasonography, bone scans and magnetic resonance imaging which, while excluding other causes of groin pain, did not show much abnormality.[24]

Kluin et al. interpret that migration of the lipoma or lymph node in the inguinal canal in conditions of high intra-abdominal pressure, will give local pain during sports activities.[8] In our series a possible cause of chronic groin pain was found in forty per cent of the patients diagnosed with a 'sportsman' hernia. This concerned weakness of the posterior wall (14%), preperitoneal lipomas (14%) and lymph nodes (12%) observed near the internal ring of the inguinal canal.

Operative repair often cures athletes with chronic groin pain in the presence of a palpable inguinal hernia.[8,14,31] Following surgical repair of a clinically not recognizable hernia variable success rates (63% to 95%) have been reported.[1,2,12,15,30,32]

Treatment of chronic groin pain in athletes is always aimed toward its specific pathology. First-line management includes strengthening and stretching exercises, physiotherapy, anti-inflammatory analgesics, local analgesics, corticosteroid injections, and -in resistant cases- surgery.[4,11,17] Several operative approaches for groin pain in athletes have been proposed depending on the suspected nature of injury. This includes diverse methods of hernia repair tenotomies of muscle tendons close to the pubic bone as well as releasing or transecting of nearby nerves.[15,17,31,33] Many studies have reported a success rate with surgical intervention of 63-90 per cent.[1,11,12,30,32,34]

Endoscopic repair of groin disruptions however has theoretical advantages. The posterior position of the mesh behind the conjoint tendon and pubic bone should create a stronger repair than conventional surgery using anterior mesh placement. Endoscopic groin exploration with subsequent hernia repair when necessary, offers a faster recovery with less postoperative pain.[15,16,26,27]

A TEP repair of ‘sportsman’s hernia’ must be proposed to patients with prolonged groin pain unresponsive to conservative treatment or with failure to determine the etiology of pain. Subsequently an adductor longus muscle tenotomy should be considered only in athletes who suffer from persistent pain in the adductor muscle region with tendocalcinosis seen on the ultrasonography. Adductor Tendonitis must be caused by pelvic instability together with weakness of the inguinal wall.[14]

This study shows that even if no clear pathology is identified at endoscopic exploration, reinforcement of the inguinal posterior wall using a mesh offers good clinical results in athletes with idiopathic groin pain.

References

1. Hackney RG. The sports hernia: a cause of chronic groin pain. Br J Sports Med 1993;27(1):58-62.
2. Steele P, Annear P, Grove JR, et al. Surgery for posterior inguinal wall deficiency in athletes Long-term follow-up of laparoscopic preperitoneal hernia repair in professional athletes. J Sci Med Sport 2004;7(4):415-21; discussion 22-3.
3. Kemp B.S. BME. The 'Sports Hernia' A Common Cause of Groin Pain. The physician and sportsmedicine 1998;26(1):36-44.
4. Lynch SA, Renstrom PA. Groin injuries in sport: treatment strategies. Sports Med 1999;28(2):137-44.
5. Slavotinek JP, Verrall GM, Fon GT, Sage MR. Groin pain in footballers: the association between preseason clinical and pubic bone magnetic resonance imaging findings and athlete outcome. Am J Sports Med 2005;33(6):894-9.
6. Zimmerman G. Groin pain in athletes. Aust Fam Physician 1988;17(12):1046-52.
7. Lovell G. The diagnosis of chronic groin pain in athletes: a review of 189 cases. Aust J Sci Med Sport 1995;27(3):76-9.
8. Kluin J, den Hoed PT, van Linschoten R, JC IJ, van Steensel CJ. Endoscopic evaluation and treatment of groin pain in the athlete. Am J Sports Med 2004;32(4):944-9.
9. Brannigan AE, Kerin MJ, McEntee GP. Gilmore's groin repair in athletes. J Orthop Sports Phys Ther 2000;30(6):329-32.
10. Gilmore J. Groin pain in the soccer athlete: fact, fiction, and treatment. Clin Sports Med 1998;17(4):787-93.
11. Fon LJ, Spence RA. Sportsman's hernia. Br J Surg 2000;87(5):545-52.
12. Polglase AL, Frydman GM, Farmer KC. Inguinal surgery for debilitating chronic groin pain in athletes. Med J Aust 1991;155(10):674-7.
13. Holmich P, Uhrskou P, Ulnits L, et al. Effectiveness of active physical training as treatment for long-standing adductor-related groin pain in athletes: randomised trial. Lancet 1999;353(9151):439-43.
14. Renstrom P, Peterson L. Groin injuries in athletes. Br J Sports Med 1980;14(1):30-6.
15. Ingoldby CJ. Laparoscopic and conventional repair of groin disruption in sportsmen. Br J Surg 1997;84(2):213-5.
16. Susmallian S, Ezri T, Elis M, Warters R, Charuzi I, Muggia-Sullam M. Laparoscopic repair of "sportsman's hernia" in soccer players as treatment of chronic inguinal pain. Med Sci Monit 2004;10(2):CR52-4.
17. Paajanen H, Syvahuoko I, Airo I. Totally extraperitoneal endoscopic (TEP) treatment of sportsman's hernia. Surg Laparosc Endosc Percutan Tech 2004;14(4):215-8.
18. Srinivasan A, Schuricht A. Long-term follow-up of laparoscopic preperitoneal hernia repair in professional athletes. J Laparoendosc Adv Surg Tech A 2002;12(2):101-6.
19. Tung GA, Brody JM. Contemporary imaging of athletic injuries. Clin Sports Med 1997;16(3):393-417.
20. Morelli V, Smith V. Groin injuries in athletes. Am Fam Physician 2001;64(8):1405-14.
21. Genitsaris M, Goulimaris I, Sikas N. Laparoscopic repair of groin pain in athletes. Am J Sports Med 2004;32(5):1238-42.
22. Akita K, Niga S, Yamato Y, Muneta T, Sato T. Anatomic basis of chronic groin pain with special reference to sports hernia. Surg Radiol Anat 1999;21(1):1-5.
23. Irshad K, Feldman LS, Lavoie C, Lacroix VJ, Mulder DS, Brown RA. Operative management of "hockey groin syndrome": 12 years of experience in National Hockey League players. Surgery 2001;130(4):759-64; discussion 64-6.

24. Ziprin P, Williams P, Foster ME. External oblique aponeurosis nerve entrapment as a cause of groin pain in the athlete. Br J Surg 1999;86(4):566-8.
25. Fricker PA. Management of groin pain in athletes. Br J Sports Med 1997;31(2):97-101.
26. Liem MS, van Duyn EB, van der Graaf Y, van Vroonhoven TJ. Recurrences after conventional anterior and laparoscopic inguinal hernia repair: a randomized comparison. Ann Surg 2003;237(1):136-41.
27. Neumayer L, Giobbie-Hurder A, Jonasson O, et al. Open mesh versus laparoscopic mesh repair of inguinal hernia. N Engl J Med 2004;350(18):1819-27.
28. Gullmo A. Herniography. The diagnosis of hernia in the groin and incompetence of the pouch of Douglas and pelvic floor. Acta Radiol Suppl 1980;361:1-76.
29. Malycha P, Lovell G. Inguinal surgery in athletes with chronic groin pain: the 'sportsman's' hernia. Aust N Z J Surg 1992;62(2):123-5.
30. Smedberg SG, Broome AE, Elmer O, Gullmo A. Herniography in the diagnosis of obscure groin pain. Acta Chir Scand 1985;151(8):663-7.
31. Taylor DC, Meyers WC, Moylan JA, Lohnes J, Bassett FH, Garrett WE, Jr. Abdominal musculature abnormalities as a cause of groin pain in athletes. Inguinal hernias and pubalgia. Am J Sports Med 1991;19(3):239-42.
32. Schneider R, Kaye J, Ghelman B. Adductor avulsive injuries near the symphisis pubis. Radiology 1976;120(3):567-9.
33. Akermark C, Johansson C. Tenotomy of the adductor longus tendon in the treatment of chronic groin pain in athletes. Am J Sports Med 1992;20(6):640-3.
34. Horsky I, Huraj E. [Surgical treatment of the painful groin]. Acta Chir Orthop Traumatol Cech 1984;51(4):350-3.

Chapter 10

General Discussion

R.N. van Veen

Pain

In most randomized controlled studies local anesthesia is compared with both spinal and general anesthesia. In only one small trial regional anesthesia is compared with local anesthesia in a two armed trial. The mentioned trials have shown benefits for local anesthesia and have recommended local anesthesia as the method of choice.[1-6] Local anesthesia is almost exclusively the method of choice in centers with special interest in inguinal hernia surgery.[7-10] Nevertheless, it is remarkable that in general surgical practice regional and general anesthesia are preferred[1,11,12] and currently only seven per cent of all inguinal hernia repairs are carried out under local infiltration anesthesia in the Netherlands.[13]

We performed a randomized controlled clinical trial comparing local anesthesia with spinal anesthesia. Local anesthesia is superior to spinal anesthesia in inguinal hernia repair performed by general surgeons. Local anesthesia provides benefits for the patients in terms of highly satisfactory intraoperative analgesia, faster recovery, less postoperative pain, no urinary retention, faster mobilization and higher satisfaction throughout the first three months. Benefits for the hospital are: significantly shorter total operating time, operation executed without interference of an anesthesiologists, reduction of total costs,[14] and a reduced length of hospital stay. Furthermore, incorporation of local infiltration anesthesia technique by general surgeons is easy. Still, forty per cent of anesthesiologists in the Netherlands prefer to use spinal anesthesia.[13]

Our study clearly shows that local anesthesia in primary inguinal hernia repair should be the method of choice **(Chapter 2)**. All effort should be made to eliminate the use of spinal anesthesia for groin hernia repair. As a result of this trial we expect a decrease of regional anesthesia and an increased implementation of local infiltration anesthesia for inguinal hernia repair in The Netherlands.

The golden standard of hernia repair changed rigorously from non-mesh to mesh repair within the last years. Our research group demonstrated that after 3 year follow-up, mesh inguinal hernia repair is superior compared to non-mesh repair with respect to recurrence.[15] Concomitant with popularisation of mesh inguinal hernia repair, it has become clear that morbidity associated with this operation mainly consists of postoperative chronic groin pain, affecting daily activities in about 10% of patients.[16,17]

Chronic Pain

Chronic groin pain after mesh inguinal hernia repair may be somatic, neuropathic or visceral in origin. Aasvang and Kehlet suggest that intraoperative nerve damage may

be a prerequisite for developing a chronic pain state.[18] Studies regarding the effect of peroperative inguinal nerve identification and subsequent division or preservation were evaluated. **(Chapter 3)**. The incidence of chronic pain is significantly less after identification of all three inguinal nerves than after no identification at all. No significant difference in chronic pain was found in case of identification with subsequent preservation compared to division of the ilioinguinal nerve. We believe that inguinal nerves should be identified during open repair of hernia. In terms of outcome, there is little difference between dividing or preserving the ilioinguinal nerve after identification. Pragmatic division of the genital branch of the genitofemoral nerve seems beneficial.

Long term randomized studies with 5-year follow-up to investigate chronic groin pain after open mesh versus non-mesh hernia repair have not been published. To determine influence of the introduction of mesh material on the incidence of chronic pain, we conducted a randomized double-blind study of open non-mesh versus mesh hernia repair. The results up to 3 years of follow-up were published by Vrijland et al; indicating that mesh repair is comparable to non-mesh repair with respect to chronic postoperative pain at 1, 6, 12, 18, 24 and 36 months.[15] Our 10 year follow-up study provides evidence that mesh repair of inguinal hernia is equal to non-mesh repair with respect to long term chronic pain. An important new finding is that chronic postoperative pain of neuropathic or somatic origin seems to dissipate over time.[19-21] Our data give insight into the course of chronic pain. We suggest that neuropathic pain after inguinal nerve injury is predominantly caused by changes in the central nervous system.[19] Because chronic pain can be debilitating, this knowledge is interesting from patient's perspective and, therefore, from the doctor perspective as well. **(Chapter 4)**.

Indirect inguinal hernias (Nyhus type I)[22] arise from incomplete obliteration of the processus vaginalis, the embryological protrusion of peritoneum that precedes testicular descent into the scrotum. The processus vaginalis normally obliterates postnatally.[23] Failure of this obliterative process results in a patent processus vaginalis (PPV); a possible congenital indirect inguinal hernia.[24] To determine in what degree PPV is a risk factor for the development of inguinal hernia in adults (Nyhus type II),[22] long-term follow-up is of great importance.

After a mean follow-up time of 5.5 years for patients with an obliterated processus vaginalis (OPV) and 5.3 years for patients with a patent processus vaginalis (PPV)|, 3 versus 12 per cent inguinal hernias were found respectively (Chapter 5). The chance of developing an inguinal hernia within 5.3 year in patients diagnosed with PPV appeared to be four times higher compared to patients with OPV (Odds ratio 4.3). We can conclude that PPV is a risk factor for the development of groin hernia.

Long term follow-up

Data on long-term rates of recurrence in mesh techniques are hardly available. [25]To investigate whether mesh repair is favourable in the long term with respect to recurrence, long-term follow-up was executed of a randomized controlled trial comparing mesh with non-mesh inguinal hernia techniques.[15] **(Chapter 6)** We conclude that recurrences of inguinal hernia continue to occur up to 10 years after conventional hernia repair. It is therefore likely that recurrence rates are generally underestimated, because most studies are either not prospective or do not include long-term follow-up.[26,27]

It is well known that the reported recurrence rates are influenced not only by surgical expertise and method of repair, but also by the length and method of follow-up.[26, 28] Physical examination in all patients is of eminent importance to reduce the amount of false-negative results. The importance of an adequate length of follow-up is shown by the fact that 50% of recurrences occurred after a 3-year follow-up period in our study.[29] Although time-consuming and incomplete because of patients who have deceased or are lost to follow-up our data indicate that long-term follow-up in the outpatient clinic is mandatory in any study dealing with recurrence of inguinal hernia repair.

The Dutch inguinal hernia guidance suggests that Lichtenstein repair is the repair of choice for unilateral inguinal hernia.[30] The short-term and long-term results of our randomized controlled trial comparing mesh with non-mesh inguinal hernia techniques are in accordance with the Dutch guidelines.[15]

Endoscopic repair

The guidance however leaves room for endoscopic repair for the treatment of especially bilateral groin hernias, recognizing the benefits of preperitoneal repair combined with advantages of minimally invasive surgery.[30]

Since more surgeons have adapted the endoscopic extraperitoneal approach, TEP hernia repair has been criticized because of its complexity, high costs, risk of major complications and the need for general anaesthesia.

A drawback of the laparocopic approach in inguinal hernia repair is the risk of major complications.[31,32] In total extraperitoneal hernia repair (TEP), the procedure is performed within the preperitoneal space. The peritoneal space is avoided, presumably leading to a considerable reduction in the risk of major vascular complications, intestinal obstructions and perforations. Peritoneal defects occur in approximately 10% to 47% of endoscopic hernia repairs.[33-35]

In a meta-analysis of randomized trials comparing open and laparoscopic unilateral inguinal hernia repair,[36] a trend was detected towards an increase in the relative probability of short-term hernia recurrence after laparoscopic repair. However, this trend was only found for TAPP compared with open hernia repair and not for trials comparing TEP with open hernia repair. None of the differences observed were statistically significant. Endoscopic total extraperitoneal repair seems to be associated with an increased duration of operation, shorter hospital stay and earlier return to work compared to open inguinal hernia repair. Although hospital costs are higher, TEP does not seem to produce an increase in total expenses, including costs of sick leave. In our systematic review we conclude that recurrence rates after TEP seem to be comparable with, if not better than, rates following open methods of repair. **(Chapter 7)** These data are in accordance with the Cochrane review by McCormack et al.[29]

Retrospective and prospective studies on the results of endo-/laparoscopic inguinal hernia repair, including bilateral repair, go back to 1994 describing a 0 to 10.1 per cent recurrence rate at follow-up.[33,34,37-40] Data on long term rates of recurrence in TEP inguinal hernia repair, however, are hardly available.[25] We provided long term results of TEP inguinal hernia repair in a prospective trial to evaluate recurrence rates after 10 years. **(Chapter 8)**. An important new finding in this study is that recurrences of inguinal hernia continue to occur up to 10 years after endoscopic hernia repair. In a small number of patients in this study operated endoscopically after previous conventional hernia repair, all recurrences occurred after 5 years. It is therefore likely that recurrence rates of endoscopic techniques are generally underestimated, because most studies are either not prospective or do not include long-term follow-up. Irving L. Lichtenstein et al. established the basis for current inguinal hernia surgery and reported 1000 consecutive patients with primary mesh repair followed-up from 1 year to 5 years without recurrence.[41] Our randomized controlled long-term follow-up trial claims a recurrence rate of 1% after Lichtenstein inguinal hernia repair.[29] In a recent meta-analysis of randomized trials comparing open and laparoscopic inguinal hernia repair,[40] a trend was detected towards an increase in the relative probability of short-term hernia recurrence after laparoscopic repair. These outcomes established the Lichtenstein tension-free hernioplasty as the gold standard for primary inguinal hernia surgery in The Netherlands. Future long term follow-up randomized trials comparing Lichtenstein inguinal hernia repair with TEP repair are needed to determine the difference in recurrence rate.

Chronic exercise-related groin pain

Chronic exercise-related groin pain can be a debilitating condition, particularly in athletes. Clinically, “sportman’s hernia” is characterized by insidious-onset, gradually worsening, diffuse groin pain. It may radiate along the inguinal ligament, perineum and rectus muscles. Radiation of pain across the midline, down the inside of the thigh into the adductor area, into the scrotum and testicles is present in about 30 per cent of symptomatic patients.[42-44]

Giving support to the theory that posterior weakness is the prime cause of groin pain in athletes, a mesh is placed resolving the problem of the posterior weakness in the inguinal wall. Our pilot study was designed to determine specific findings in athletes who are diagnosed with a sportsman’s hernia and to evaluate the effectiveness of TEP.[40,45-47] TEP repair of sportsman’s hernia must be proposed to patients with prolonged groin pain which is unresponsive to conservative treatment and/or with failure to determine the etiology of pain. Even if no clear pathology is identified at endoscopic exploration, reinforcement of the inguinal posterior wall using a mesh offers good clinical results in athletes with idiopathic groin pain in our pilot study. **(Chapter 9)**.

Future perspectives in inguinal hernia repair

Since the introduction of polyethylene plastic mesh by Usher in 1956, the quest for the ideal mesh has begun. The ideal mesh is not altered by tissue fluids, does not excite an inflammatory or foreign body reaction that interferes with its clinical applicability and is not carcinogenic or will elicit an allergic reaction in tissue. Contrarily, the prosthesis must allow tissue ingrowth, but fibrosis must not be overdeveloped as nerves may get involved. This overdevelopment of collagen can sometimes be observed using polypropylene meshes (‘meshoma’). In time, scar tissue is well known to weaken and stretch and cannot be relied on for the long-term integrity necessary for hernia repair. Therefore, the ultimate success of prosthetic herniorrhaphy with any biomaterials must rely on the health of the surrounding fascia to which the prosthesis must be securely sutured, without undue tension.

Monofilament synthetic mesh almost meets all the mentioned expectations. Therefore, It is currently the most popular mesh used in inguinal hernia repair.

Newly developed lightweight and partially absorbable meshes are promising to reduce chronic pain.[48] Other modalities to fix the mesh in the groin area, without the need for suturing, might be another focus of investigation. Glue is an alternative to sutures for mesh fixation in inguinal hernia repair, preventing nerve entrapment.

Combining these techniques with local infiltration anesthesia will be associated with a low incidence of local and general complications including a reduction of chronic postoperative groin pain.

The Dutch national hernia guidelines propose open (tension-free) repair as the first choice in general practice, reservating endoscopic repair for endoscopic surgeons.[30] It is obvious that endoscopic hernia repair is more difficult to perform than the open technique, which can result in more failures in inexperienced hands. The suboptimal outcome of endoscopic hernia surgery performed by inexperienced surgeons as part of their general practice have raised questions of specialization in hernia surgery. Hernia centers with specialized hernia surgeons who concentrate on endoscopic techniques are to be expected in The Netherlands.

Surgical repair has been advocated as a standard treatment even for asymptomatic and mildly symptomatic inguinal hernia to avoid incarceration with strangulation, which requires emergent operation associated with relatively high morbidity and mortality rates. Elective inguinal hernia repair is a safe procedure even at high age. It has been reported that elective repair for patients aged over 80 was not associated with an increase in 30-day mortality, while emergent operation for strangulation hernia carried a 20-fold risk of death.[49]

Among patients admitted to the hospital because of inguinal hernia, more than two third are mildly symptomatic without impairments in usual activities.[50]

A randomized clinical trial recently started by our study group evaluating wait and see policy (watchfull waiting) for asymptomatic or mildly symptomatic inguinal hernia might conclude that watchful waiting is an option for almost all asymptomatic or mildly symptomatic inguinal hernias in adult men. It may be preferred in those with ASA (American Society of Anethesiologists) score III or more, in whom mortality risk after inguinal hernia surgery is significantly increased.[49]

Conclusions of this thesis:

Local anesthesia in primary, inguinal hernia repairs should be considered as a method of choice **(Chapter 2)**.
The incidence of chronic pain is significantly less after identification of all three inguinal nerves than after no identification at all **(Chapter 3)**.
Postoperative chronic groin pain, seems to dissipate over time **(Chapter 4)**.

Patent processus vaginalis is a risk factor for the development of indirect inguinal hernia **(Chapter 5)**.

Mesh repair remains superior to non-mesh inguinal hernia repair over time **(Chapter 6)**.

Endoscopic total extraperitoneal repair appears to be associated with an increased duration of operation, shorter hospital stay and earlier return to work compared to open inguinal hernia repair **(Chapter 7)**.

Recurrences of inguinal hernia continue to occur up to 10 years after endoscopic hernia repair **(Chapter 8)**.

Endoscopic reinforcement of the inguinal posterior wall using a mesh offers good clinical results in athletes with idiopathic groin pain (**Chapter 9)**.

References

1. Hair A, Duffy K, McLean J, et al. Groin hernia repair in Scotland. Br J Surg 2000; 87(12):1722-6.
2. Nordin P, Bartelmess P, Jansson C, et al. Randomized trial of Lichtenstein versus Shouldice hernia repair in general surgical practice. Br J Surg 2002; 89(1):45-9.
3. Song D, Greilich NB, White PF, et al. Recovery profiles and costs of anesthesia for outpatient unilateral inguinal herniorrhaphy. Anesth Analg 2000; 91(4):876-81.
4. Gonullu NN, Cubukcu A, Alponat A. Comparison of local and general anesthesia in tension-free (Lichtenstein) hernioplasty: a prospective randomized trial. Hernia 2002; 6(1):29-32.
5. Gultekin FA, Kurukahvecioglu O, Karamercan A, et al. A prospective comparison of local and spinal anesthesia for inguinal hernia repair. Hernia 2007; 11(2):153-6.
6. Friemert B, Faoual J, Holldobler G, et al. [A prospective randomized study on inguinal hernia repair according to the Shouldice technique. Benefits of local anesthesia]. Chirurg 2000; 71(1):52-7.
7. Amid PK, Shulman AG, Lichtenstein IL. Open “tension-free” repair of inguinal hernias: the Lichtenstein technique. Eur J Surg 1996; 162(6):447-53.
8. Kark AE, Kurzer MN, Belsham PA. Three thousand one hundred seventy-five primary inguinal hernia repairs: advantages of ambulatory open mesh repair using local anesthesia. J Am Coll Surg 1998; 186(4):447-55; discussion 456.
9. Callesen T, Bech K, Kehlet H. One-thousand consecutive inguinal hernia repairs under unmonitored local anesthesia. Anesth Analg 2001; 93(6):1373-6, table of contents.
10. Bendavid R. The Shouldice repair. New York: Springer, 2001.
11. Nordin P, Haapaniemi S, van der Linden W, Nilsson E. Choice of anesthesia and risk of reoperation for recurrence in groin hernia repair. Ann Surg 2004; 240(1):187-92.
12. Kehlet H, Bay Nielsen M. Anaesthetic practice for groin hernia repair--a nation-wide study in Denmark 1998-2003. Acta Anaesthesiol Scand 2005; 49(2):143-6.
13. de Lange DH, Aufenacker TJ, Roest M, et al. Inguinal hernia surgery in The Netherlands: a baseline study before the introduction of the Dutch Guidelines. Hernia 2005; 9(2):172-7.
14. Nordin P, Zetterstrom H, Carlsson P, Nilsson E. Cost-effectiveness analysis of local, regional and general anaesthesia for inguinal hernia repair using data from a randomized clinical trial. Br J Surg 2007; 94(4):500-5.
15. Vrijland WW, van den Tol MP, Luijendijk RW, et al. Randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia. Br J Surg 2002; 89(3):293-7.
16. Aasvang EK, Bay-Nielsen M, Kehlet H. Pain and functional impairment 6 years after inguinal herniorrhaphy. Hernia 2006; 10(4):316-21.
17. Poobalan AS, Bruce J, Smith WC, et al. A review of chronic pain after inguinal herniorrhaphy. Clin J Pain 2003; 19(1):48-54.
18. Aasvang E, Kehlet H. Chronic postoperative pain: the case of inguinal herniorrhaphy. Br J Anaesth 2005; 95(1):69-76.
19. Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: risk factors and prevention. Lancet 2006; 367(9522):1618-25.
20. Cunningham J, Temple WJ, Mitchell P, et al. Cooperative hernia study. Pain in the postrepair patient. Ann Surg 1996; 224(5):598-602.
21. Poobalan AS, Bruce J, King PM, et al. Chronic pain and quality of life following open inguinal hernia repair. Br J Surg 2001; 88(8):1122-6.
22. Nyhus LM. Individualization of hernia repair: a new era. Surgery 1993; 114(1):1-2.
23. McGregor DB, Halverson K, McVay CB. The unilateral pediatric inguinal hernia: Should the contralateral side by explored? J Pediatr Surg 1980; 15(3):313-7.

24. Abrahamson J. Etiology and pathophysiology of primary and recurrent groin hernia formation. Surg Clin North Am 1998; 78(6):953-72, vi.
25. Scott NW, McCormack K, Graham P, et al. Open mesh versus non-mesh for repair of femoral and inguinal hernia. Cochrane Database Syst Rev 2002(4):CD002197.
26. Vos PM, Simons MP, Luitse JS, et al. Follow-up after inguinal hernia repair. Questionnaire compared with physical examination: a prospective study in 299 patients. Eur J Surg 1998; 164(7):533-6.
27. Haapaniemi S, Nilsson E. Recurrence and pain three years after groin hernia repair. Validation of postal questionnaire and selective physical examination as a method of follow-up. Eur J Surg 2002; 168(1):22-8.
28. Beets GL, Oosterhuis KJ, Go PM, et al. Longterm followup (12-15 years) of a randomized controlled trial comparing Bassini-Stetten, Shouldice, and high ligation with narrowing of the internal ring for primary inguinal hernia repair. J Am Coll Surg 1997; 185(4):352-7.
29. van Veen RN, Wijsmuller AR, Vrijland WW, et al. Long-term follow-up of a randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia. Br J Surg 2007; 94(4):506-10.
30. Simons MP, de Lange D, Beets GL, et al. [The 'Inguinal Hernia' guideline of the Association of Surgeons of the Netherlands]. Ned Tijdschr Geneeskd 2003; 147(43):2111-7.
31. Darzi A, Paraskeva PA, Quereshi A, et al. Laparoscopic herniorrhaphy: initial experience in 126 patients. J Laparoendosc Surg 1994; 4(3):179-83.
32. Kald A, Anderberg B, Smedh K, Karlsson M. Transperitoneal or totally extraperitoneal approach in laparoscopic hernia repair: results of 491 consecutive herniorrhaphies. Surg Laparosc Endosc 1997; 7(2):86-9.
33. Liem MS, van der Graaf Y, van Steensel CJ, et al. Comparison of conventional anterior surgery and laparoscopic surgery for inguinal-hernia repair. N Engl J Med 1997; 336(22):1541-7.
34. Knook MT, Weidema WF, Stassen LP, van Steensel CJ. Endoscopic total extraperitoneal repair of primary and recurrent inguinal hernias. Surg Endosc 1999; 13(5):507-11.
35. Lau H, Patil NG, Yuen WK, Lee F. Management of peritoneal tear during endoscopic extraperitoneal inguinal hernioplasty. Surg Endosc 2002; 16(10):1474-7.
36. Memon MA, Cooper NJ, Memon B, et al. Meta-analysis of randomized clinical trials comparing open and laparoscopic inguinal hernia repair. Br J Surg 2003; 90(12):1479-92.
37. Fitzgibbons RJ, Jr., Camps J, Cornet DA, et al. Laparoscopic inguinal herniorrhaphy. Results of a multicenter trial. Ann Surg 1995; 221(1):3-13.
38. Topal B, Hourlay P. Totally preperitoneal endoscopic inguinal hernia repair. Br J Surg 1997; 84(1):61-3.
39. Knook MT, Weidema WF, Stassen LP, et al. Endoscopic totally extraperitoneal repair of bilateral inguinal hernias. Br J Surg 1999; 86(10):1312-6.
40. Neumayer L, Giobbie-Hurder A, Jonasson O, et al. Open mesh versus laparoscopic mesh repair of inguinal hernia. N Engl J Med 2004; 350(18):1819-27.
41. Lichtenstein IL, Shulman AG, Amid PK, Montllor MM. The tension-free hernioplasty. Am J Surg 1989; 157(2):188-93.
42. Fricker PA. Management of groin pain in athletes. Br J Sports Med 1997; 31(2):97-101.
43. Morelli V, Smith V. Groin injuries in athletes. Am Fam Physician 2001; 64(8):1405-14.
44. Hackney RG. The sports hernia: a cause of chronic groin pain. Br J Sports Med 1993; 27(1):58-62.
45. Liem MS, van Duyn EB, van der Graaf Y, van Vroonhoven TJ. Recurrences after conventional anterior and laparoscopic inguinal hernia repair: a randomized comparison. Ann Surg 2003; 237(1):136-41.

46. Ingoldby CJ. Laparoscopic and conventional repair of groin disruption in sportsmen. Br J Surg 1997; 84(2):213-5.
47. Susmallian S, Ezri T, Elis M, et al. Laparoscopic repair of “sportsman’s hernia” in soccer players as treatment of chronic inguinal pain. Med Sci Monit 2004; 10(2):CR52-4.
48. O’Dwyer PJ, Kingsnorth AN, Molloy RG, et al. Randomized clinical trial assessing impact of a lightweight or heavyweight mesh on chronic pain after inguinal hernia repair. Br J Surg 2005; 92(2):166-70.
49. Nilsson H, Stylianidis G, Haapamaki M, et al. Mortality after groin hernia surgery. Ann Surg 2007; 245(4):656-60.
50. Hair A, Paterson C, Wright D, et al. What effect does the duration of an inguinal hernia have on patient symptoms? J Am Coll Surg 2001; 193(2):125-9.

Appendices

Samenvatting

De liesbreukcorrectie is de meest uitgevoerde algemeen chirurgische ingreep in Nederland.

In ***Hoofdstuk 1*** wordt het onderwerp van dit proefschrift geïntroduceerd: Nieuwe klinische benaderingen in de behandeling van de liesbreuk.

De aandacht gaat achtereenvolgens uit naar de anatomie van het liesgebied, incidentie en risicofactoren van liesbreuken, de diagnose, classificatie, keuze van anesthesie en de therapie. Bij de behandeling van liesbreuken wordt nader ingegaan op de superioriteit van mesh gebruik bij liesbreukcorrecties en de endoscopische correctie. Chronische pijn en langdurige follow-up hebben invloed op de behandelingskeuze.

Hoofdstuk 2 behandelt de regionale en locale methoden van anesthesie bij liesbreukcorrecties volgens de methode van Lichtenstein. In Nederland wordt slechts 7% van alle liesbreukcorrecties uitgevoerd onder locale infiltratie anesthesie. Dit in tegenstelling tot de VS en de UK waar respectievelijk 70% en 40% van de liesbreukcorrecties onder locale anesthesie wordt uitgevoerd.

Het doel van deze prospectieve gerandomiseerde studie is om locale anesthesie te vergelijken met spinale anesthesie; de vorm van anesthesie die in Nederland het meest wordt toegepast bij liesbreukcorrecties. Analyse van postoperatieve pijnscores scores (VAS score), gecorrigeerd voor de preoperatieve VAS score, geslacht en leeftijd, toont geen significant verschil in postoperatieve pijn tussen de locale en spinale groep. De pijnbeleving kort postoperatief is significant lager na locale anesthesie. Ondanks dat de patiënten in opzet in dagbehandeling werden geopereerd, moesten significant meer patiënten na spinale anesthesie 1 nacht of meer in het ziekenhuis blijven. Dit kwam mede doordat patiënten na spinale anesthesie significant meer last hadden van urineretentie. Urineretentie kwam in de locale groep niet voor. Ondanks dat door de ‘richtlijnen liesbreuk’ locale infiltratie anesthesie wordt aanbevolen, is het wonderlijk dat gezien bovenstaande feiten locale anesthesie bij liesbreukcorrecties weinig toegepast wordt in Nederland.

Hoofdstuk 3 behelst een systematische review over het identificeren en sparen van inguinale zenuwen. Door een toename van mesh-technieken en dientengevolge een afname van recidiefper centages, wordt chronische pijn na liesbreukcorrecties een steeds belangrijker aandachtspunt. Identificeren en sparen van inguinale zenuwen heeft invloed op de postoperatieve morbiditeit. Wij concluderen dat zenuwen tijdens de liesbreukoperatie geïdentificeerd dienen te worden en zo mogelijk gespaard.

In een prospectief gerandomiseerde studie die na 3 jaar follow-up mesh en non-mesh techniek bij liesbreukcorrecties vergelijkt heeft 6% van de patiënten last van chronische liespijn. Een belangrijke nieuwe bevinding is dat chronische liesklachten met de tijd afnemen. Na 10 jaar follow-up komen chronische liesklachten niet voor.

Dit is de enige studie die resultaten over chronische pijn beschrijft na liesbreukcorrecties, over een periode die langer is dan 5 jaar ***(Hoofdstuk 4)***.

In 2004 werden in Nederland 33.000 primaire liesbreuken gecorrigeerd (www.prismant.nl). Ondanks dat de liesbreukcorrectie mondiaal één van de meest uitgevoerde operaties is, bleek er weinig bekend over de etiologie van liesbreuken bij volwassenen. In ***Hoofdstuk 5*** wordt de open processus vaginalis beschreven. De processus vaginalis sluit normaal gesproken binnen de eerste twee levensjaren. Echter, 12 procent van de onderzochte groep bleek een open processus vaginalis te hebben, hetgeen een risicofactor is om een indirecte liesbreuk te ontwikkelen. Wij concludeerden dat een open processus vaginalis bij mannen een predisponerende factor is om een indirecte liesbreuk te ontwikkelen op volwassen leeftijd.

Recidiefper centages voor liesbreukcorrecties variëren tussen 0.2 en 33%. Niet eerder is er een mesh vs non-mesh lange termijn follow-up onderzoek beschreven, hetgeen noodzakelijk is om een beter inzicht te krijgen in de werkelijke incidentie van recidieven na open liesbreukchirurgie. ***(Hoofdstuk 6)***

Na 10 jaar follow-up van een gerandomiseerde trial die mesh vs non-mesh techniek bij liesbreukcorrecties vergelijkt, is het recidief per centage bij mesh gebruik significant lager vergeleken met de non-mesh groep. In de mesh groep werd bij gebruik van prolene mesh geen recidief gediagnosticeerd. Enkele recidieven >5 jaar na de operatiedatum zijn in de non-mesh groep gediagnosticeerd, hetgeen de noodzaak van lange termijn follow-up onderstreept.

In de ‘richtlijnen liesbreuk’ wordt aanbevolen om bij alle volwassen patiënten met een symptomatische liesbreuk een techniek met mesh te gebruiken, aangezien het gebruik van mesh leidt tot minder recidieven. In de richtlijn wordt beschreven dat endoscopische liesbreukchirurgie tot de opties behoort als deze techniek uitgevoerd wordt door getrainde teams die deze ingreep regelmatig uitvoeren. Endoscopische liesbreukoperaties leiden tot een sneller postoperatief herstel en kortere opnameduur vergeleken met open liesbreukcorrecties. De techniek is echter wel duurder (ziekenhuiskosten), maar doordat patiënten eerder aan het werk kunnen zijn de maatschappelijk kosten even hoog als bij open liesbreukchirurgie. ***(Hoofdstuk 7)***

Op lange termijn neemt het aantal recidieven na endoscopische liesbreukoperaties toe. In ***Hoofdstuk 8*** wordt beschreven dat na 10 jaar follow-up van endoscopische liesbreukcorrecties volgens de TEP techniek, alle recidieven na 5 jaar ontstaan. Het betreft hier een TEP operatie na een reeds eerder recidief van een conventionele liesbreukoperatie. Ook bij deze studie wordt de noodzaak van lange termijn follow-up benadrukt. In de toekomst zullen TEP en open liesbreukcorrecties vergeleken worden om op lange termijn de superioriteit qua recidieven te bepalen.

Chronische liesklachten bij (top)sporters heeft een incidentie tussen de 0.5% en 6.2% en komt voornamelijk voor bij voetballers en ijshockeyers. Klinisch presenteert de klacht zich zonder aanwijsbare oorzaak. De pijn in de lies neemt langzaam diffuus toe en straalt uit tot aan het perineum en de buikwandmusculatuur. Een liesbreuk is slechts in enkele gevallen te diagnosticeren.

In ***Hoofdstuk 9*** wordt aangetoond dat de TEP liesbreukcorrectie een betrouwbare en effectieve methode is om chronische liesklachten bij (top)sporters te behandelen. Recent is een prospectief gerandomiseerde studie gestart om de diagnostische endoscopie te vergelijken met de TEP bij atleten met chronische liesklachten.

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List of Publications

Staarink M, **van Veen RN**, Hop WC, Weidema WF.
10 year follow-up of endoscopic total extraperitoneal repair of primary and recurrent inguinal hernia.
Accepted Surg Endosc. 2008.

van Veen RN, Mahabier C, Dawson I, Hop WC, Kok NFM, Lange JF, Jeekel J.
Spinal Or Local Anesthesia in Lichtenstein hernia repair; a randomised controlled trial.
Accepted Ann Surg. 2008.

van Veen RN, Wijsmuller AR, Vrijland WW, Hop WC, Lange JF, Jeekel J.
Randomized clinical trial of mesh versus non-mesh primary inguinal hernia repair: long-term chronic pain at 10 years.
Surgery. 2007 Nov;142(5):695-8.

van Veen RN, Wijsmuller AR, Vrijland WW, Hop WC, Lange JF, Jeekel J.
Long-term follow-up of a randomized clinical trial of non-mesh versus mesh repair of primary inguinal hernia.
Br J Surg. 2007 Apr;94(4):506-10.

Wijsmuller AR, **van Veen RN**, Bosch JL, Lange JF, Kleinrensink GJ, Jeekel J, Lange JF.
Nerve management during open hernia repair.
Br J Surg. 2007 Jan;94(1):17-22.

van Eijck FC, **van Veen RN**, Kleinrensink GJ, Lange JF.
Hartmann's gallbladder pouch revisited 60 years later.
Surg Endosc. 2007 Jul;21(7):1122-5.

Kuhry E, **van Veen RN**, Langeveld HR, Steyerberg EW, Jeekel J, Bonjer HJ.
Open or endoscopic total extraperitoneal inguinal hernia repair? A systematic review.
Surg Endosc. 2007 Feb;21(2):161-6.

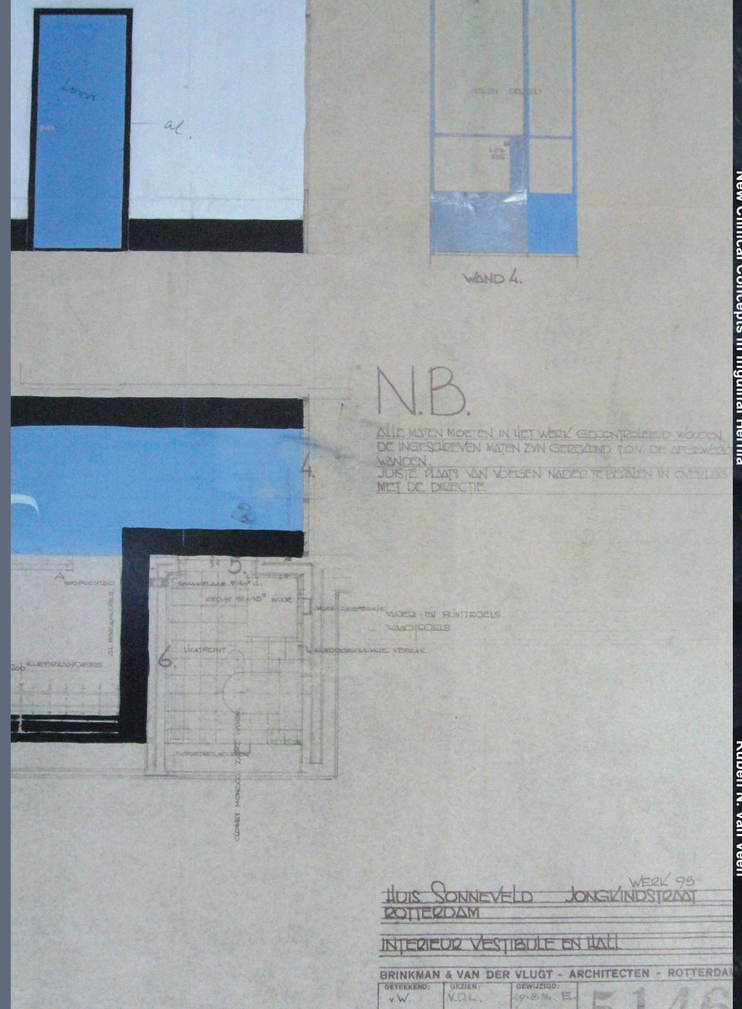
van Veen RN, de Baat P, Heijboer MP, Kazemier G, Punt BJ, Dwarkasing RS, Bonjer HJ, van Eijck CH.
Successful endoscopic treatment of chronic groin pain in athletes.
Surg Endosc. 2007 Feb;21(2):189-93.

van Veen RN, van Wessem KJ, Halm JA, Simons MP, Plaisier PW, Jeekel J, Lange JF.
Patent processus vaginalis in the adult as a risk factor for the occurrence of indirect inguinal hernia.
Surg Endosc. 2007 Feb;21(2):202-5.

de Jongh FE, **van Veen RN**, Veltman SJ, de Wit R, van der Burg ME, van den Bent MJ, Planting AS, Graveland WJ, Stoter G, Verweij J.
Weekly high-dose cisplatin is a feasible treatment option: analysis on prognostic factors for toxicity in 400 patients.
Br J Cancer. 2003 Apr 22;88(8):1199-206.

Curriculum Vitae

Ruben Nico van Veen werd 6 mei 1978 te 's-Gravenhage, als zoon van Nico Cornelis van Veen en Editha Alexia Maria van Veen-van der Koelen, geboren. In 1997 behaalde hij het VWO-diploma (atheneum-β) aan het Comenius college te Capelle aan den IJssel. In datzelfde jaar begon hij aan de Erasmus Universiteit te Rotterdam de studie Geneeskunde. In november 2003 werd het artsexamen behaald. Vervolgens werkte hij 3 maanden als AGNIO-heelkunde in het IJsselland Ziekenhuis te Capelle aan den IJssel. In maart 2003 volgde een aanstelling als arts-onderzoeker op de afdeling Algemene Heelkunde (afdelingshoofd: prof. dr. J.Jseekel, opleider: prof. dr. J.N.M. IJzermans) van het Erasmus MC onder leiding van prof. dr. J. Jeekel en prof. dr. J.F. Lange.
Sinds 1 juli 2006 is hij in opleiding tot chirurg in het Ikazia ziekenhuis te Rotterdam (opleider: dr. W.F. Weidema).



New Clinical Concepts in Inguinal Hernia

Ruben N. van Veen

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door
Ruben Nico van Veen

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