SUBFASCIAL ENDOSCOPIC PERFORATING VEIN SURGERY

SUBFASCIAL ENDOSCOPIC PERFORATING VEIN SURGERY

(Subfasciale endoscopische chirurgie van perforerende venen)

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Engelbertus Gerardus Johannes Maria Pierik

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OVERIGE LEDEN:	Prof. dr J. Jeekel Prof. dr J.S. Laméris Prof. dr H.A.M. Neumann
CO-PROMOTOR:	Dr C.H.A. Wittens

Pierik, E.G.J.M.

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'Maar het indrukwekkendste was wel de wond op haar enkel,
die gloeide en etterde door het geknoei van de kwakzalvers.'
Over de liefde en andere duivels. Gabriel García Márquez

Aan Paula

CONTENTS

1

GENERAL INTRODUCTION

Leg ulcers caused by chronic venous insufficiency have long been a concern of patients and physicians alike, because of its high prevalence and the difficulties encountered in establishing satisfactory healing. Venous ulceration is the end stage of chronic venous insufficiency and up to recently little progress in the surgical treatment of this disease has been made. Last decade, however, new less invasive surgical approaches have been published with promising results concerning ulcer healing and postoperative morbidity.

1.1 Anatomy of the veins of the lower limb

A thorough knowledge of the anatomy of the venous system of the lower limb is essential for the surgical correction of those abnormalities that underlie venous ulceration[1,2].
The venous drainage of the lower limb is divided into a superficial and deep system, the drainage areas of which are separated by a fascia. This deep fascia of the leg invests the whole of the limb muscles closely, especially at the lower half of the leg where it becomes a tough aponeurosis which encloses the soleus muscle firmly and constitutes an essential part of the so called 'calf-muscle pump'[3]. The superficial veins are large, compared to the deep veins relatively thick walled, muscular structures that lie just under the skin. They collect the venous blood from the subcutaneous tissues and skin and eventually empty into the deep veins. The superficial venous system consists of two main channels, the long saphenous vein (LSV) and the short saphenous vein (SSV) which communicate with one another via a multitude of unnamed subcutaneous vessels. They terminate by piercing the deep fascia of the fossa ovalis and the middle or uppermost third of the calf respectively, to empty into the deep system. In the lower leg and - to a lesser extent - in the thigh, the superficial venous system, however, also communicates with the deep system via a series of perforating (or communicating) veins, the majority of which are inconstant in position and

number. Although in the Anglo-American and German literature 'venae perforantes' and 'venae communicantes' are frequently used synonymously, in more recent studies on the functional anatomy of the venous system it is suggested to use venae perforantes only for veins which connect the superficial with the deep system, and reserve venae communicantes to describe the connecting branches within each system[4,5].

Perforating veins are of paramount importance in connection with the problem of (recurrent) varicose veins, and even more so with reference to venous ulceration of the lower leg[1,3,6,7]. These perforator veins perforate the deep fascia on their way to the deep veins, are predominantly found below the knee, and vary in number from 90 to 200[2,8,9]. They are varying in diameter from less than 1 mm to 2 mm in diameter[10]. Sometimes small arteries, lymphatic vessels and/or cutaneous nerves accompany the perforating veins through the same fascial opening[11]. Le Dentu originally described the perforating veins as direct or indirect[12]. Direct perforators pass directly from the superficial veins to the deep veins and indirect perforators interrupt their course into muscular venous channels before terminating in the deep system. This distinction is somewhat artificial but the direct perforating veins are generally more constant in position, larger and hemodynamically more important than the indirect veins[6]. According to Gay, the perforating veins usually start from subcutaneous veins of secondary size, i.e. tributaries of the saphenous trunks, and not from the main vessels[13]. Between 50 and 100 unnamed indirect perforating veins enter the muscles before joining the deep veins. They are usually accompanied by a small artery and are primarily accompanying veins of small cutaneous arteries[6]. These are not normally important but may dilate and become hemodynamically significant following deep vein thrombosis, recanalization and reflux[1]. Most indirect perforating veins, however, are too small to be capable of significant dilatation and are considered unimportant[3,6].

Clinically much more important are the direct perforating veins. The great saphenous vein has two direct communications with the deep system in the thigh; its entrance in the common femoral vein and a relatively constant perforating vein approximately 15 cm proximal to the level of the knee (Hunterian perforator or Dodd's vein)[3]. Incompetence of this perforator is a common cause of recurrent varicose veins of the long saphenous vein following saphenofemoral ligation without stripping[7]. The remaining direct perforating

veins of the leg do not communicate directly with the LSV but do communicate with its tributaries. Of particular interest to the surgeon are a series of about six medial calf perforators (often called Cockett's veins) that join the posterior tibial vein through a network of superficial veins known as the posterior arch vein[14]. It is the main tributary of the LSV in the lower leg. This vein arises as a result of the confluence of a series of calcaneal branches posterior to the medial malleolus. This channel ascends the posteromedial aspect of the leg and terminates at a variable distance below the knee by entering the LSV. It is this vein and not the LSV which communicates directly with the deep venous channels via the medial leg perforators. Thus it can be appreciated that in the erect position the essential venous drainage of what is known as the ulcer-bearing area is taken directly into the deep veins, and not into the saphenous system. On the other hand, the effects of venous incompetence in the long or short saphenous systems can readily reach this area via their connections with the venous arches linking these perforating veins[3]. Because of the above mentioned anatomic relations, stripping of the LSV from groin to ankle does not interrupt these calf perforating veins.

Another important structure in the lower leg is the saphenous nerve which has an intimate relationship with the LSV at the level of the knee joint after it emerges from the subsartorial canal. It accompanies the vein anteriorly through the leg to the medial aspect of the dorsum of the foot and it is in this area that the nerve may be damaged during careless dissection of the vein or 'long' stripping of the LSV, often resulting in saphenous nerve neuralgia. The deep veins lie under the deep fascia, accompany arteries, often as venae comitantes, and bear the same names as the arteries they parallel (i.e. the peroneal, posterior tibial, anterior tibial, popliteal or femoral vein). They are thin walled and less muscular than the superficial veins. The deep system forms the major pathway for the return of blood from the legs to the heart.

All the venous channels in the lower limb contain valves which facilitate flow in a centripetal direction in the axial vessels, and from the superficial to the deep system in the perforating veins. Although the classic teaching is that the valves of perforating veins permit blood to flow only from the superficial to the deep venous system, a recent study, however, has shown that outward flow can occur in about one fifth of normal limbs under experimental conditions (isolated proximal calf compression with use of a cuff)[15]. The same study showed the only reliable criterion of abnormality in perforating veins of the calf to be

reverse flow during the relaxation phase after distal compression of the foot, which occurred only in limbs with evidence of venous disease[15].

1.2 Epidemiology of venous leg ulceration

A chronic venous leg ulcer can be defined as an area of discontinuity of the epidermis of the lower leg, persisting for 4 weeks or more, occurring as a result of venous hypertension and calf muscle pump insufficiency[16]. It is noticed as a very common problem in clinical practice in the Western world. The scarcity, however, of epidemiological studies on the incidence of this disease probably reflects a general lack of interest in a chronic, non-fatal condition which mainly affects the elderly. Where reports are confined to active venous leg ulcers, the point prevalences are quoted as between 0.06% and 1%[17,18]. Because of the recurring cycle of ulcer healing and breakdown, prevalence studies of active ulcers almost certainly underestimate the true number of patients. In studies where patients with a history of ulcer disease (active or currently inactive ulceration) are included, the overall prevalence is between 1% and 1.3% of the total population[19,20]. At any one time, approximately one-fifth of patients affected with venous ulcer disease suffer an open ulcer[17,20].
Nelzen and colleagues estimated in a recently published study in the British Journal of Surgery the overall prevalence of lower limb ulceration (open and healed) to be even 2.1%, with a ratio open:healed ulcers to be 1:2[21]. They found a high rate of "self treatment" in their study population, especially in people below retirement age which explains the underestimated prevalences of previous epidemiological studies (which were mainly based on postal surveys of general practitioners and district nurses).
The large Lothian and Forth Valley Leg Ulcer Study, based on a postal survey in two health board areas in Scotland (with a population of about one million people) demonstrated that most patients suffering from leg ulcers were women and that the condition was more common in the elderly, the median age of the men being 67 years (range 22-96) and of the women 74 years (range 21-100)[20]. This is in concordance with Baker et al. who found 90% of their Australian patients with chronic venous ulcers over 60 year old (median 75; range 20-99 years) with a distinct female predominance[18].
Translation of the above-mentioned prevalence figures to the Dutch population (1.6% of 15.400.000 inhabitants) would mean more than 245.000 patients with

venous ulceration of the lower leg in the Netherlands. A number which only will grow in future due to the aging of our population.

1.3 Socio-economic aspects

As stated in the previous paragraph, venous ulcers are a major health problem in terms of the number of people affected. The high recurrence rates after conservative treatment (reported in 46-66% after initial healing)[22,23] lead to a large number of patients in need of definitive treatment. This is not only a burden on the afflicted patients, but also on the financial resources of a country's health care system.
However, economic data on the actual cost of venous leg ulcer disease to the health system and the community are scarce.
Michael Hume estimated the costs of nursing visits and dressing materials per patient afflicted with an unhealed leg ulcer in the U.S. at $1927.89 per month. Extrapolated to the nation as a whole yields a figure exceeding $192 million per year[24]. However, the costs of care in clinics and nursing homes must be added as well as the indirect costs, as time lost from work, permanent disability and forced early retirement, to calculate the actual economic consequences of venous ulceration. Because of these amounts he proposed that improvement in the care of venous ulcers of the leg deserves to become a priority in vascular surgery[24].
Economic data, presented from the Riverside study conducted in London, suggested that the nursing costs alone of leg ulceration in Great Britain (population 55 million) amount to between 100 and 140 million Pound Sterling annually[25]. Moffatt and his colleagues estimated a total cost of £375 million for the treatment of venous ulcer patients in the United Kingdom per year[26]. Based on their estimation of costs per ulcer, per patient, per year, a very rough estimation would mean that approximately 1.8 billion Dutch guilders is spent annually on the treatment of patients with venous ulceration of the lower leg in the Netherlands.

1.4 The cause of venous ulceration

Ambulatory venous hypertension is the final common pathway in the pathogenesis of venous ulceration of the lower limb[27]. It arises as the result of

incompetence of the valves of the leg veins and the associated phenomenon of venous reflux or retrograde flow. The more extensive and the more distal this reflux, the greater the probability that an ulcer will occur[28,29].
The cause of venous hypertension may be located solely in the superficial venous system. Varicose veins may occur here as a result of primary venous dilatation with secondary valvular incompetence. During the last decade, it has become clear that superficial venous incompetence *alone* may lead to ulceration. The proportion of these patients with isolated superficial insufficiency varies widely in different series, but has recently been reported as even up to 50% of cases of venous ulceration[30].
In the deep venous system valvular destruction principally occurs as the result of recanalization following deep venous thrombosis. Congenital venous valvular aplasia, venous obstruction, calf muscle dysfunction and arteriovenous malformations are rare causes of venous dysfunction accounting for only a small proportion of all patients with venous ulceration[31].
The relative proportions of the two main causes of venous hypertension (varicose veins and post-thrombotic limb) in patients with ulceration are disputed and vary in different studies. Hanrahan et al. evaluated the location of venous incompetence in 95 extremities with venous ulceration by means of duplex imaging[32]. Isolated or combined incompetence in the superficial, deep and perforator system was identified in 79, 50 and 63% of the legs respectively. In a similar study in 34 legs with venous ulcers, Labropoulos et al. found isolated or combined incompetence of the superficial system in 91%, the deep system in 70% and of the perforator system in only 44%[33].
Probably related to the preciseness of the duplex scanning other groups found incompetent perforating veins in the large majority of the legs of patients with venous ulceration[15,34,35] which is in concordance with customary findings during surgical exploration of these patients[36-41].
The exact mechanism, however, by which venous hypertension ultimately may lead to skin ulceration remains uncertain.
The fibrin cuff hypothesis put forward by Browse and Burnand in 1982, suggested that with increased venous pressure, the permeability of capillaries increases and allows large molecules, in particular fibrinogen, to escape into the interstitial tissue[42]. Fibrinogen then polymerizes into fibrin to form pericapillary fibrin cuffs. These cuffs act as a diffusion barrier, preventing oxygen and other nutrients from reaching the skin and resulting in cell death and ulceration.

Coleridge Smith and co-workers proposed in 1988 another hypothesis for the cause of venous ulceration[43]. Their 'white cell hypothesis' postulates that an increase in venous pressure during standing or walking causes a reduction in capillary flow rate, resulting in trapping of white blood cells in the leg. The trapped white cells may cause 'plugging' of the capillaries and result in areas of ischaemia around these capillary loops, and become activated, releasing toxic oxygen metabolites (free radicals), proteolytic enzymes and chemotactic substances that attract more white cells.
As with the fibrin cuff hypothesis, the white cell hypothesis awaits to be proven.

1.5 Treatment modalities of venous ulceration

The treatment of patients with venous ulceration of the leg can be divided in conservative and operative approaches.
Conservative treatment is based on bed rest, leg elevation, ulcer cleaning and ulcer dressings, injection sclero-therapy and (ambulant) compression therapy. In the Netherlands most venous ulcers are treated by the avoidance of positions of limb dependency, good hygiene and skin care, control of associated infection and ambulant compression therapy[44]. After the ulcer has healed, pressure gradient stockings are generally advised to wear in order to decrease the incidence of recurrence.
Ambulant compression therapy is one of the most powerful conservative instruments in the treatment of venous ulceration. The stockings or bandages should be applied so as to produce a pressure gradient, with higher pressures at the ankle and lower pressures at the knee. The bandage should be applied by trained, skilled professional personnel[45]. The success of ambulant compression therapy, however, depends to a great extent on the compliance and mobility of the patient. Walking and exercises should be encouraged.
It is current practice to cover ulcers with dressings prior to bandaging the legs. However, no dressing of any type has been proven to enhance the healing rate of venous ulcers[46]. Also the routine use of topical pharmacological agents such as antibiotics, is probably unnecessary[47]. Although in the future perhaps adjunctive pharmacological methods may be employed to assist and maintain the healing of venous ulcers[48], at the moment no definitive evidence of efficacy in healing of ulcers has been presented for any medication[27]. Injection sclero-therapy can be used for the treatment of superficial venous reflux and may also

be tried for the treatment of incompetent perforating veins. Naturally, a prerequisite for this last type of treatment is an accurate localization of the perforating veins.
The surgical treatment for venous leg ulcers may be directed either at eliminating the underlying cause by operating on the incompetent veins to correct venous hypertension, or at the ulcer itself by skin graft procedures[27]. Ulceration may be due to incompetence of the deep, the superficial or the perforating venous system. Isolated superficial incompetence has been reported to range from 17% to as high as one-half of cases of venous ulceration[33,49,50]. These patients will profit from ablation of superficial incompetence mostly by flush saphenofemoral or saphenopopliteal ligation and stripping of the LSV and/or SSV, as well as division of any incompetent tributaries.

Incompetent perforating veins are the single most important factor in the aetiology of venous ulceration according to some authors[3,51], and there are even those who believe that no venous ulcer exists without these veins[52,53]. Incompetent perforating veins can be ligated by either open or endoscopic approaches. Linton was the first to recommend surgical ligation of these veins as therapy in treating venous ulceration[54]. He treated his patients by open subfascial approach through three longitudinal incisions - anterolateral, posterolateral, and medial - for the complete ligation of all perforators. Later he began using only a single medial incision since most perforators could be reached through this incision. Although his operation provided an excellent access to the perforating veins and often proved to be successful in the cure of chronic venous ulceration, the high incidence of wound complications discouraged its wide clinical application. In order to minimize the postoperative complications due to an incision through often compromised skin and subcutaneous layers, new percutaneous endoscopic approaches to the subfascial area have been developed last decade[40,55,56]. However, although subfascial endoscopic perforator surgery seems a promising technique, the exact place of this approach in different clinical situations is yet unknown.
Finally and to a varying extent, the deep veins can play a role in the genesis of venous leg ulceration[27].
Burnand detected isolated or concomitant changes in the deep veins, consistent with a previous deep venous thrombosis, on ascending and descending phlebograms in 50% of all patients with venous ulcers attending a specialized ulcer clinic in London[31]. The surgical correction of this deep venous

incompetence, however, is experimental. Vein valve transplants, valvuloplasties, and venous transposition operations for deep venous insufficiency are still under development and should only be undertaken in specialized centers and in properly designed prospective trials[27].

1.6 Development of subfascial endoscopy

A number of attempts have been made to interrupt incompetent perforating veins while at the same time avoiding a long incision through the often compromised, lipodermato-sclerotic skin, with its poor healing properties.
In 1965, Albanese described a totally new approach to the problem of perforator vein incompetence with the development of a new cutting instrument, which was later modificated by Edwards[57,58]. This "phlebotome" was introduced under the deep fascia some distance away from the area of lipodermatosclerosis or ulceration and blindly sheared off all perforating veins. Edwards reported the absence of postoperative wound complications after treatment of 24 patients with varicose veins with this technique[58]. However, although postoperative wound problems were minimized, disadvantages included the blind fashion of this method and the resulting frequent occurrence of painful subfascial hematoma formation. More seriously, use of the phlebotome in an elderly woman with very thin legs and friable skin resulted in an area of skin necrosis[1].

The combination of ligation under direct visual control and Edwards introduction site led to the development of endoscopic techniques. During the last decade, a number of ingenious attempts have been made to avoid long incisions and to identify incompetent perforating veins under direct vision. The first documented attempt involved the use of a laryngoscope, whose straight blade was passed subfascially through a small calf incision by David Negus[1]. Traction on the blade, to elevate the deep fascia away from the muscles and illumination, was intended to visualize the incompetent perforating veins which could then be controlled by clips using a long applicator. His attempts to perform this seemingly simple technique have been unsuccessful due to inadequate visibility down the subfascial space. However, the introduction of laparoscopy in general surgery successfully spurred the further investigation of minimally invasive approaches to venous surgery.

1.7 Surgical endoscopic techniques

The first successful subfascial endoscopic identification and ligation of incompetent perforating veins by an endoscopic tube through which a coagulation forceps and scissors could be passed, was described by Hauer in 1985[55]. The instruments advocated by Hauer (an angulated scope and its offset fiberoptic lighting and video camera) however, were expensive and difficult to manipulate. A readily available and familiar instrument, the mediastinoscope, was used by others and this endoscopic technique to identify the perforating veins proved to be simple and successful[40].
At the same time, Conrad in Australia and Gloviczki in the U.S.A. developed a carbon-dioxide insufflation technique as used in laparoscopic surgery. This creates a wide subfascial space ("cave-view") through which perforator interruption can be easily accomplished[56]. However, maintaining gas pressure is difficult and the fascial seal is frequently interrupted by manipulation of the scope. O'Donnell used physiologic liquid distention of the subfascial space with irrigation of the area to be explored[59]. He feels that Ringer's lactate solution infused through the subfascial space is safer than the use of CO_2 which might penetrate the circulation. Gerhart Sattler subsequently refined the endoscopic instrumentation by developing angulated optics allowing the mounting of a video camera at a 45-degree angle, thus providing an 11 mm working channel to be used with a 30 cm scope. It is, however, presently impossible to introduce a clipping instrument through this operating sheath, so all perforating veins have to be coagulated and severed with scissors.

Since the first report in 1985, a growing number of studies have been published reporting encouraging results with the endoscopic approach in patients with primary varicosis, lipodermatosclerosis and venous ulceration of the lower leg[40,41,56,60-64]. However, these studies all had a retrospective design of mixed patient populations without control groups. Up until now, no prospective, randomized study has been published comparing open and endoscopic techniques in a uniform patient population.
To stimulate further international development of endoscopic perforator surgery several groups working on this subject are meeting each other regularly to work up their experiences and study the probable future of this method[41,64].

1.8 Outline of the thesis

This thesis is based on six publications on the subject of subfascial endoscopy of incompetent perforating veins in patients with venous ulceration:

1. A review article on the surgical treatment of incompetent perforating veins which exposes the importance of incompetent perforating veins and describes the different surgical approaches in detail. This publication is found in chapter 2.
2. The second publication is a report of our endoscopic technique of subfascial endoscopy by use of a mediastinoscope and a clipping instrument. It describes the specific dangers and complications of this technique in chapter 3.
3. The third publication reports on the results of subfascial endoscopy in 38 patients with recurrent or protracted venous ulceration of the lower leg. In this retrospective study wound complication, ulcer healing and recurrence rates were reported after a follow-up of almost 4 year. This study is discussed in chapter 4.
4. In order to evaluate the clinical value of subfascial endoscopy, a prospective randomized trial was conducted in patients with active venous ulceration of the leg. Open exploration according to Linton was compared to endoscopic exploration with a mediastinoscope. The ulcer healing rates and postoperative complication rates were analyzed in this trial. After 39 patients an interim analysis was performed, the results of which are discussed in chapter 5.
5. In chapter 6 the sensitivity and specificity of duplex ultrasonography in detecting the number and localization of competent and incompetent perforating veins in patients with venous ulcers is investigated. The preoperative and postoperative duplex findings in our study were compared with the findings at open exploration.
6. In order to evaluate the efficacy of subfascial endoscopy in eradicating incompetent perforating veins, an analysis was made of the preoperative, peroperative and postoperative number and localization of incompetent perforating veins in relation to the healing of the ulcer after endoscopic exploration of the subfascial area. These results are discussed in chapter 7.
7. In chapter 8 a summary is given in the English and Dutch language, and final conclusions are drawn.

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2

THE SURGICAL TREATMENT OF INCOMPETENT PERFORATING VEINS

C.H.A. Wittens, E.G.J.M. Pierik and H. van Urk[1]

Department of Surgery, Sint Franciscus Gasthuis, Rotterdam, The Netherlands
[1]Department of Surgery, Vascular Unit, University Hospital Rotterdam - Dijkzigt, Rotterdam, The Netherlands.

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Introduction

Ulceration of the skin of the lower limb has been recorded as an affliction of the human race since the time of Hippocrates. It is almost certainly the price we pay for having emerged from the ocean and learned to stand erect[1]. The association between ulceration at the ankle and venous disorders of the lower limb has been known for over 2000 years and compression therapy is referred to in the Old Testament (Isaiah 1:6) and is mentioned by Hippocrates as well[2]. During Roman times, a number of physicians, including Celsus and Galen, advised the use of plasters and linen bandages in the treatment of leg ulcers[3]. Until the Middle Ages, however, the philosophy of treatment of venous ulcer was dominated by Galen's black bile theory and his erroneous but influential views on venous bloodflow. Physicians attributed ulceration of the legs to the accumulation of black bile, bad humours, menstrual blood and faeculant humours and were convinced that healing of the ulcer would be catastrophic, causing "melancholy, madness, dropsy, palpitation....and other things"[4,5].
The first documented operations in the treatment of venous insufficiency were performed around 1850[5]. Madelung was the first who excised the greater saphenous vein through a long incision over the medial aspect of the leg and thigh; a formidable procedure associated with considerable morbidity and mortality[6]. In 1907, Babcock in New York devised the intraluminal stripper for the extirpation of the greater saphenous vein in patients with varicose veins[7]. The origins of venous ulcer surgery, however, reside in the work of Gay and Homans.

Importance of incompetent perforating veins

An important contribution to present knowledge was made by John Gay in 1867[8]. He described the perforating veins of the calf and ankle, recorded the fact that ulcers could occur in the absence of varicose veins, and introduced the term "venous ulcer"[9]. Gay's work, however, seems to have been overlooked by early twentieth century writers.
In the late 1910s John Homans wrote his papers about the etiology and treatment of the "varicose ulcer" of the leg, "a poor man's disease", and he was the first who clearly established the relationship between previous deep vein thrombosis, valve destruction following recanalization and ulceration of the leg[10,11]. Homans

described two types of ulcers. One was attributable to the familiar type of varicose veins and is generally healed by adequate removal of these superficial veins. The other, "post-phlebitic", type was more rapid in development, intractable to palliative treatment and generally incurable by the removal of varicose veins alone. Homans recognized the potential consequences of deep venous thrombosis and noticed "the presence, beneath the sole leather base of the ulcer, of a huge, dilated, incompetent, perforating vessel". However, his treatment was focused on excision of the ulcer and split-thickness skin grafting[11].

Subcutaneous and subfascial approaches to the perforating veins

Robert Linton first recognized the necessity of interrupting incompetent perforating veins following deep phlebitis to cure varicose ulcers. Descriptions of these veins, however, were scanty and incomplete. And "since a more accurate knowledge of these veins was found necessary for the proper treatment of varicose veins and ulcers" Linton first studied and described the anatomy of the perforating veins of the lower extremity[12] after which he developed his radical surgical treatment[12,13]. His classic operation had a four-fold purpose: removing all enlarged superficial veins, subfascial ligating and dividing all perforating veins of the lower leg, interrupting the superficial femoral vein distal to the profunda femoral vein and finally partial excision of the deep fascia of the lower leg in an attempt to restore the lymphatic drainage.
His initial technique involved three longitudinal incisions - anterolateral, posterolateral, and medial - for the complete ligation of the perforators. In 1953 he began using only a medial incision since most perforators could be reached through this incision. This operation, however, still necessitated an incision through unhealthy skin and fat for a direct approach to the incompetent perforating veins. Although Linton preferred to perform this procedure after the ulcerations had been healed completely by bed rest and compression therapy, he himself noticed already that his incision did not always heal completely by primary union. Although the operation proved to be often successful, it was complicated by delayed wound healing, skin necrosis and wound infection in up to 58% of the cases[14-17]. However, since Linton's paper, the cornerstone in the treatment of venous ulcers is based on preventing the abnormal transmission to the superficial veins of the high (ambulatory) pressures generated within the deep veins by interruption of the perforating veins.

To avoid wound complications, multiple modifications of Linton's technique have been advocated. Cockett advised not to cleave the deep fascia surrounding the soleus muscle because of its role in the calf pump mechanism. He performed, in addition to excision of the ulcer, an *extra*fascial ligation of the incompetent perforators[14]. However, this subcutaneous exploration has become obsolete because of many disappointing explorations due to difficulties with identification of perforating veins. Dodd described a posteromedial subfascial approach to obviate dissection of unhealthy skin[18]. The Rob procedure included posterior subfascial ligation of perforating veins via a long, "stocking seam" incision[19]. A final modified operative approach to the problem of woundhealing was described by De Palma in 1974 who used multiple small parallel oblique skin incisions in the natural skin lines along the medial aspect of the lower extremity[20]. He proposed subcutaneous as well as subfascial dissection, depending on the degree of lipodermatosclerosis.

However, in the same period, many others abandoned surgery for post-thrombotic vein incompetence and turned to injection sclerotherapy[21-23]. This was instigated because of the high complication rate of traditional surgical methods as well as growing controversy about the role of calf perforating veins in the aetiology of venous ulceration[24-27].
A prerequisite for both De Palma's method and sclerotherapy, however, is accurate localization of the perforating veins. This is of special interest because the dogma of predilection sites of perforating veins has been questioned recently[28]. Perforator detection by clinical methods[29], venography[30], infra-red photography[31], fluorescein injection with ultraviolet scanning[32] and ultrasonography[33] all has been tried, but no single method has been found to accurately identify the site of all incompetent perforating veins. The introduction of duplex-ultrasonography probably will improve these attempts but this technique is time consuming and a long training period is required before reproducible results can be obtained[34].
Although some authors still question the benefit of conventional surgical procedures, Negus and Friedgood treated 109 ulcerated legs and showed an 84% healing rate after subfascial ligation of incompetent perforating veins using the Linton and Dodd approach[33]. They suggested that a more optimistic attitude towards surgical treatment of this "crux medicorum" was justified. Good to excellent results after surgical therapy directed on the perforating veins were also described by others[16,36]. Between 1961 and 1971 over 1000 patients were

followed up after perforating vein ligation for periods ranging between 5 and 9 years, with an overall recurrence rate of 10%[37]. A review of the 10 most recent reports of subfascial ligation of perforators revealed a recurrence rate of 15% in 767 limbs[38]. Complications included deep vein thrombosis, pulmonary embolism, flap necrosis, wound infections, and a wound complication rate of 17%. These recurrence and complication rates were found in patients in whom all types of medical management had failed and thus represented the most severe expressions of venous insufficiency. Besides these empirical data, objective evidence that ligation of perforating veins is of benefit can be found in the improved postoperative venous function as measured by foot volumetry in patients who underwent subfascial ligation of perforating veins with or without saphenous vein ligation for recurrent venous ulceration[39].

Recently, the role of popliteal vein incompetence, acting as a critical gatekeeper for the calf muscle pump, has been discussed as a potential risk factor for recurrent ulceration after subfascial ligation of perforators[40,41]. The question remains whether elastic stockings can maintain long-term healing following surgery in these patients by compressing the long saphenous vein on the dorsum of the foot and anterior surface of the ankle and thus prevent the transmission of high venous pressures from deep to superficial ankle veins[8]. At the same time, a subgroup of patients with venous ulceration without any sign of deep venous insufficiency has been recognized[42-44]. These patients, having chronic superficial venous insufficiency, with or without incompetent perforating veins, will benefit even more from surgery directed to varicose and perforating veins. A surgical answer to deep vein incompetence may be found in venous valve surgery. During the last decade interest in this field of surgery has intensified and a number of reports have appeared describing new methods for valve repair and valve replacement using homografts, xenografts and prosthetic materials[45]. These methods are based on the concept that correction of venous reflux, especially in the deep system, improves calf pump function and will lead to resolution of ulceration. Although the first results of venous valve surgery were promising[46], most studies have a limited number of patients and short follow-up only. Therefore, as long as vein valve transplantations, valvuloplasties and venous transposition operations for deep venous insufficiency are still under development, they should only be undertaken in specialized centers and in properly designed prospective clinical trials[47].

New surgical techniques for interruption of perforating veins

A number of attempts have been made to interrupt incompetent perforating veins by avoiding a long incision through compromised, lipodermatosclerotic skin, with poor healing properties.
A.R. Albanese and J.M. Edwards described a totally new approach to the problem of perforating vein incompetence with the development of a new cutting instrument[48,49]. This "phlebotome" is introduced under the deep fascia some distance from the area of lipodermatosclerosis and blindly sheares off the perforating veins. Although this concept was brilliant and postoperative wound-problems were minimized, disadvantages are the blind fashion of this method and the frequent occurrence of painful subfascial hematoma formation as well as skin necrosis[8].
Combination of the advantages of Edwards introduction site and a treatment under direct visual control led to the recent development of percutaneous, endoscopic techniques. The use of fibre-optics[50], rigid endoscopic instrumentarium[51] or a mediastinoscope[52,53] allows subfascial ligation and sectioning of all perforating veins under direct vision and with minimal trauma.
Up till now, only a few retrospective studies have been published about the results of endoscopic dissection. Jugenheimer and Junginger reported acceptable results of endoscopic subfascial sectioning of incompetent perforating veins in 103 legs of 72 patients with primary varicosis[54]. In this retrospective study subfascial endoscopy was combined with conventional varicoexeresis in 94%. Postoperative delayed wound healing was observed in only 2.9%. Two patients (1.9%) complained of dysesthesia in the area of distribution of the sural nerve. Other complications were: extended subcutaneous hematoma in 5.8% and postoperative dysesthesia in the area of distribution of the saphenous nerve in 9.7%. However, the question remains unanswered whether these complications were associated with the endoscopic procedure or with vein stripping. After a mean follow-up of 27 months newly formed or persistent incompetent perforating veins were detected in two patients (1.9%). Severe subfascial infection, necessitating surgical reintervention on both legs, was described in a patient operated on both sides by Wittens et al[52]. Using a mediastinoscope, 40 recurrent or protracted venous leg ulcers were treated by subfascial endoscopy[53]. After a mean follow-up of 3.9 years only one patient (2.5%) developed a recurrent ulcer.

Endoscopic subfascial dissection of incompetent perforating veins seems a new, promising technique, gaining ground as a surgical alternative in the treatment of venous ulceration which is in line with the renewed interest in venous surgery as well as the modern trend towards minimally invasive surgery[55,56]. More studies, however, are needed to define the exact place of endoscopic techniques in different clinical situations. The accessibility of submalleolar perforating veins, the feasibility after preceding subfascial explorations, the possible learning curve and the specific complications need to be clarified. At the moment, a prospective, randomized study is underway in Rotterdam, the Netherlands, to evaluate this technique in comparison with the classic open exploration in patients with active venous ulceration.

Epilogue

Chronic venous ulceration of the leg is a common clinical problem. Reports dealing with active venous leg ulcers only, mention a prevalence of between 0.06% and 1%[57,58]. In studies where patients with a history of ulcer disease (active or currently inactive ulceration) are included, the overall prevalence is between 1% and 1.3%[59,60]. Almost all venous ulcers can be treated by simple means, of which firm compression is the most important. Although the majority of venous ulcers can be healed by an outpatient regimen of graduated compression bandaging and elevation, many of these ulcers will recur. In the Lothian and Forth Valley survey, 66% of 600 patients studied had suffered multiple episodes of venous ulceration over a 5-year period and 45% had suffered from intermittent ulceration for more than 10 years[61]. Even when patients are fully compliant and committed to optimal conservative treatment, up to 29 per cent of ulcers recur within 5 years[62]. Consequently, healing of venous ulceration is only half the story and the efficacy of any particular form of treatment must largely depend on the prevention of recurrence. The capability of recurrent ulcer prevention must be determined by a careful follow-up regimen for a reasonably long period[23]. Twenty experts on the field of venous ulcer disease have recently formulated in a consensus paper valuable considerations for any clinical trial on treatment of venous leg ulcers[47]. However, only very few prospective randomized trials on the treatment of patients with venous ulceration have been carried out.

In view of recent developments in surgical endoscopic techniques as well as better understanding of the hemodynamics of incompetent calf perforating veins[27,63] a new period in the surgical treatment of venous ulceration may be expected.

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3

ENDOSCOPIC LIGATION OF PERFORATING VEINS USING A MEDIASTINOSCOPE

E.G.J.M. Pierik, H. van Urk[1], and C.H.A. Wittens

Department of Surgery, Sint Franciscus Gasthuis, Rotterdam, The Netherlands
[1]Department of Surgery, Vascular Unit, University Hospital Rotterdam-Dijkzigt, Rotterdam, The Netherlands.

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Abstract

Incompetent perforating veins play a major role in venous ulceration and recurrence of varicose veins. To reduce postoperative wound problems associated with classic subfascial exploration of the lower leg endoscopic approaches have been developed. We describe a technique which makes use of a mediastinoscope to explore the subfascial area. This cheap and readily available instrument is present in most operating rooms. Although a learning curve must be anticipated, the results of this technique in retrospective studies seem promising.
Keywords: venous ulceration, subfascial endoscopy, endoscopic ligation of perforating veins.

Introduction

Chronic venous ulceration of the leg is a common problem in clinical practice. Where reports are confined to active venous leg ulcers, reported prevalences are between 0.06% and 1%[1,2]. In studies where patients with a history of ulcer disease (active or healed ulceration) are included, the prevalence is quoted up to even 1.3%[3,4]. For purposes of comparison, the prevalence of chronic ischemic heart disease is estimated 3.1%[4b]. The direct costs of treatment of venous leg ulceration represent a considerable burden to the community. A small improvement in healing and/or recurrence rates of venous ulcers would result in important savings for health care expenses[5].
Although the pathogenesis of venous ulceration is incompletely understood, it is generally agreed that the transmission of high ambulatory venous pressures through incompetent perforating veins plays a major role[6-10]. Apart from causing venous ulceration, incompetent perforating veins are frequently responsible for recurrence of varicose veins following surgery or sclerotherapy[11].
At present, the main therapeutic approach to the treatment of incompetent perforating veins consists of either direct surgical ligation or injection of a sclerosant at the sites of junction of incompetent perforating veins with superficial veins. According to O'Donnell et al, sclerotherapy guided by clinical examination, ultrasound or ascending phlebography, however, will miss approximately 40% of the incompetent perforating veins, which is a serious disadvantage of this treatment[12]. The surgical approaches can be divided in subcutaneous and subfascial explorations. Subcutaneous exploration as described by Cockett[13]

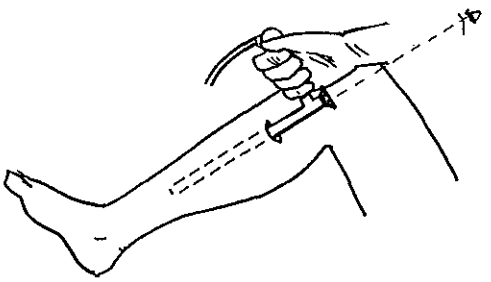
(mainly performed in the era before ultrasonic diagnostic procedures became available) has become obsolete because of many disappointing explorations due to localization problems and severe wound problems. In order to minimize the subcutaneous mobilization and to guarantee a sufficient exposure to ligate all insufficient perforating veins, the subfascial exploration was introduced. Subfascial exploration as described by Linton[14], Dodd[15] and De Palma[16] was unfortunately also complicated by a variety of wound problems because it involved incisions through unhealthy skin. Although in 1967 Arnoldi and Haeger reported "encouraging" results in the treatment of venous ulcers by perforating vein ligation, their paper bore the cryptic title of "Ulcus cruris venosum - crux medicorum?"[17].
In an attempt to replace incisions through compromised skin and thus minimize postoperative wound problems, Edwards devised his "shearing technique"[18]. A phlebotome was introduced into the subfascial space at some distance from the area of lipodermatosclerosis, after which perforating veins were dissected blindly. However, with this method, there is no way to be sure that all perforating veins have been divided and there is an inherent risk of tibial nerve injury.
Recently, in line with the general trend towards minimally invasive surgery, endoscopic techniques have been developed which allow subfascial division of perforating veins under direct vision and with minor trauma[19-21]. Because of the introduction of the instrumentarium into the subfascial space some distance from the area of skin changes or ulceration, wound problems are likely to be minimized. However, new and often complex and expensive instruments have to be purchased for these procedures. We developed a technique which makes use of a mediastinoscope. This simple, cheap and readily available instrument, present in most operating rooms, can easily be used for this purpose. In this paper we describe our experience with this technique.

Materials and Methods

The operation is performed under spinal anesthesia with the patient in a supine position, tourniquets for (partial) deprivation of blood supply are not necessary. A mediastinoscope with a length of $\pm$18 cm and a diameter of 12 mm, a light source and a long clipping instrument are used.
Through a short transverse skin incision at the anteromedial site of the proximal 1/3 of the lower leg the subcuticular tissue is dissected. The crural fascia is

exposed and incised over 2 cm after which the virtual subfascial space is opened by gentle finger dissection. The mediastinoscope is inserted and pushed down in the subfascial space to the level of the medial malleolus to separate the crural fascia from the flexors of the lower leg. During this procedure a typical crispy noise will be heard. This manoeuvre allows full examination of the subfascial area similar to "classic" open subfascial exploration (Figure 1).

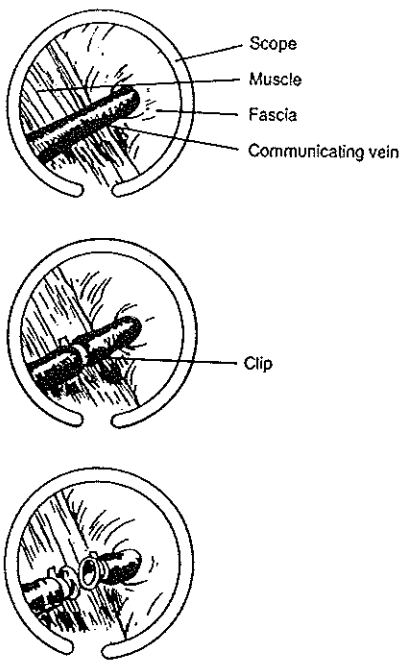
Figure 1. Schematic drawing of a mediastinoscope introduced in the subfascial space.



With the leg flexed in hip and knee, both competent and incompetent perforating veins crossing this space can be visualized, ligated with hemoclips and subsequently dissected (Figure 2). The perforating veins can be recognized because they traverse the fascia at a variable distance from the margo tibialis posterior. The nearly always accompanying small arteries, lymphatic vessels and/or cutaneous nerves can endoscopically be separated from their perforating veins but we prefer to ligate them in the same clip and routinely dissect them. When a septum intermusculare medialis is noticed it is transsected to obtain a better view of the distal subfascial area. Frequently, a perforating vein is found in this fascia which will be missed when the fascia is left intact.
Although we do not advocate paratibial fasciotomy in patients with chronic venous insufficiency routinely, splitting of the lower leg fascia can also be performed under direct vision using an endoscopic scissor, with reduced risk of iatrogenic lesion of the tibial nerve.
Due to the more superficial position of the posterior tibial artery and vein and tibial nerve in the most distal part of the lower leg caution must be taken not to confuse these structures with perforating veins. Complications may be avoided

by keeping strictly to the crural fascia in every step throughout the endoscopic procedure.
After removal of the mediastinoscope the deep fascia is left open and the skin is sutured. No drains are necessary. The leg is bandaged with cotton wool and crêpe bandages which are removed the following day. Patients are mobilized on the first postoperative day with below-knee graded compression elastic stockings.

Figure 2. Schematic drawing of the image of the subfascial space as seen through the mediastinoscope: (a) a perforating vein traversing the fascia, (b) a clipped perforating vein, (c) a clipped and divided perforating vein.



Discussion

In the past decades a number of attempts have been made to control incompetent perforating veins under direct vision whilst avoiding long skin incisions. The first "subfascial endoscopy" involved the use of a laryngoscope, whose straight

blade was passed subfascially through a high calf incision[22]. Due to inadequate vision down the subfascial tunnel attempts to perform this technique routinely have been unsuccessful[22]. The introduction of fibre-optic endoscopy enabled the development of endoscopic tubes through which bipolar endoscopic forceps and endoscopic scissors can be passed[19,20]. We have used a very simple instrument, namely a mediastinoscope to ligate incompetent perforating veins in the treatment of recurrent varicose veins and venous leg ulcers[23,24].
Up till now, only a few retrospective studies have been published about the results of endoscopic dissection of perforating veins. Jugenheimer and Junginger reported the results of endoscopic subfascial division of incompetent perforating veins in 103 legs of 72 patients with varicosis[25]. In this retrospective study subfascial endoscopy was combined with conventional varicoexeresis in 94%, without mentioning of the technique used. Postoperative delayed wound healing was observed in 2.9% legs. Two patients (1.9%) complained of dysesthesia in the area of distribution of the sural nerve. Other complications recorded were: extended subcutaneous hematoma (5.8%) and postoperative dysesthesia in the area of distribution of the saphenous nerve (9.7%). The question remains whether these complications are primarily associated with the endoscopic procedure or with stripping of the vein. After a mean follow-up of 27 months nine patients (8.7%) developed recurrent varices; in two patients (1.9%) recurrent or persistent incompetent perforating veins were detected with clinical examination and Doppler sonography.

Wittens et al described 54 legs of forty-eight patients with primary and recurrent varicose veins treated by subfascial endoscopy by use of a mediastinoscope[23]. In 49 legs (44 patients) relief of preoperative complaints was obtained and in 5 (4 patients) there was no change. Severe subfascial infection necessitating surgical reintervention on both legs was described in one patient operated on both sides. Two indurated wounds and 1 dehiscent wound were treated conservatively. No other postoperative complications were noticed.
In a retrospective series of 16 patients with active ulceration of the lower leg treated by perforating vein ligation by use of a mediastinoscope all ulcers were healed within 2 months[24]. After a mean follow-up of 3.9 years one patient developed a recurrent ulcer.
Fischer found 4.2% subfascial hematoma formation in 463 legs of patients with varicosis in which subfascial endoscopy was used[26]. The calculated risk of missing perforating veins with endoscopy leading to recurrent varicosis was

between 0.9 and 6.8% (follow-up: ½ - 5 year). Lesion of the tibial nerve occurred in one case in the beginning of his series suggesting a learning curve. Endoscopic subfascial ligation of incompetent perforating veins is a new technique in the treatment of venous ulceration and recurrent varicose veins. Reported advantages of this method are a fast and relatively simple procedure, less postoperative wound problems and good cosmesis[19-21,23-25]. A potential disadvantage is the risk to miss incompetent perforating veins as a consequence of inadequate approach and/or vision, especially the ankle perforating veins behind the medial malleolus (Cockett I)[26]. Reported complications are hematoma formation, lesion of the saphenous, sural and tibial nerve and wound healing problems. A learning curve must be anticipated. Up to now, only retrospective non-controlled studies have been reported with mixed populations and limited follow-up[23-26]. At the moment, we are conducting a prospective randomized study to evaluate this technique in patients with active venous ulceration of the lower leg, in comparison with classic open exploration. The results of this study will have to be awaited in order to better judge the merits of this technique.

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4

SUBFASCIAL ENDOSCOPIC LIGATION IN THE TREATMENT OF INCOMPETENT PERFORATING VEINS

E.G.J.M. Pierik, C.H.A. Wittens, and H. van Urk[1]

Department of Surgery, Sint Franciscus Gasthuis, Rotterdam, The Netherlands
[1]Department of Surgery, Vascular Unit, University Hospital Rotterdam-Dijkzigt, Rotterdam, The Netherlands

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Abstract

Objectives: To assess the technique of subfascial endoscopic ligation of incompetent perforatory veins by use of a mediastinoscope.
Design: Retrospective clinic study.
Setting: Two Departments of Surgery.
Materials and Methods: Thirty-eight consecutive patients (40 legs) with recurrent or protracted venous ulceration of the lower leg were treated. Through a short, transverse incision of the skin and fascia in the proximal 1/3 of the lower leg a mediastinoscope (length 18 cm, diameter 12 mm) is inserted after which the perforating veins are ligated by hemoclips under direct vision.
Main Results: All legs showed signs of incompetent perforating veins by clinical examination, confirmed with continuous wave ultrasonography and in 31 legs there was associated deep vein incompetence. Sixteen patients had active ulceration at the moment of operation and 22 had a history of recent or recurrent ulceration. One patient developed an inflammatory reaction at the wound and in two legs a subfascial infection occurred, necessitating surgical drainage. No postoperative mortality was seen. All 16 ulcers healed within 2 months (mean: 34 days; range 21-55 days). During a mean follow-up of 3.9 (range: 2-5) years only one out of 38 patients (2.5%) developed a recurrent ulcer.
Conclusions: Subfascial endoscopic ligation of incompetent perforating veins by use of a mediastinoscope is a relatively simple technique with a low postoperative complication rate and a low recurrent ulcer rate which makes it a valuable method for treating incompetent perforating veins.

Introduction

Chronic leg ulceration affects about 1% of the European population at some point in their lives[1,2]. Although the pathogenesis of venous ulceration is imperfectly understood, it is generally agreed that the transmission of high ambulatory pressures through incompetent perforating veins plays a major role[3-9].
The treatment of these incompetent perforating calf veins consists of either direct surgical ligation as described by Linton[10] or injection compression therapy popularized by Fergan[11]. Injection therapy guided by clinical examination, ultrasound or ascending phlebography will miss approximately 40% of the incompe-

tent perforating veins[12]. Since no single method predicts the site of all incompetent perforators, a full surgical exploration is essential to interrupt all incompetent perforating veins. These operations, as described by Linton[13], Cockett[14] and Dodd[15], are simple and often successful, but necessitate long incisions through compromised skin and subcutaneous layers. Consequently, delayed wound healing, skin necrosis and wound infection frequently occur and complication rates of up to 58% have been reported[16,17].

As part of the trend towards minimally invasive surgery, endoscopic techniques have been developed which allow subfascial ligation and division of perforating veins under direct vision and with minor trauma[18-20]. New and often complex instruments have been devised for this procedure.

This study reports the first results of the endoscopic, subfascial ligation of incompetent perforating veins in patients with venous ulceration, by use of a simple, cheap and readily available instrument, namely the mediastinoscope.

Patients and Methods

The study included 38 consecutive patients referred with recurrent (last ulceration less than 3 months ago) or protracted ulceration between March 1986 and April 1990. Twenty-eight women and 10 men, ranging in age from 38 to 73 years (mean age, 56.3 years) were treated. Two patients (both women) had bilateral ulcers. Thirteen patients had a history suggestive of deep vein thrombosis. Twenty patients had previously undergone unsuccessful surgery. All patients were studied by clinical examination (tourniquet-tests and palpation) and continuous wave ultrasonography. All showed symptoms and signs of incompetent perforating veins, four patients had incompetence of the long saphenous vein and in 31 patients associated deep vein incompetence was found.

Below-knee graduated elastic stockings (Class II) were fitted in all patients, with instructions to wear these pre- and postoperatively throughout the day. 16 patients still had active ulceration at the moment of operation. All patients underwent endoscopic ligation of perforating veins, in four patients additional ligation and partial stripping of the long saphenous vein was performed.

All of the 38 patients returned for follow-up examination, for a period of 2 to 5 years postoperatively (mean follow-up: 3.9 years).

Technique

The operation is performed under spinal anesthesia with the patient in supine position. After a short incision in the skin crease at the antero-medial side of the proximal 1/3 of the lower leg, the fascia is incised horizontally over 2 cm. Subsequently, the virtual subfascial space is opened by gentle finger dissection. A mediastinoscope is introduced in this space and pushed downward beneath the fascia to the level of the medial malleolus, separating the fascia from the underlying muscle.
A mediastinoscope with a length of 18 cm and a diameter of 12 mm, a light source and a long clipping instrument are used. This allows examination of the same subfascial area which is explored in the open subfascial operation. Under direct vision all perforating veins (competent and incompetent) crossing this space are ligated with hemoclips and dissected. After removal of the scope a fasciotomy of 10 cm was performed in the first 17 legs in order to prevent an anticipated muscle hernia. No drains are used and the skin is sutured in one running layer. Finally, the operated leg is covered with cotton wool and crêpe bandages. All patients were mobilized on the first postoperative day.

Results

Mean duration of the operation was 21 minutes (range: 10 - 42). During operation between 1 and 5 perforating veins (mean: 2.4) were identified and ligated. In no patient did the endoscopic approach have to be converted into open exploration.
There was no postoperative death. One patient developed an inflammatory reaction at the introduction site which was treated conservatively. One patient, operated on both legs, developed a subfascial infection on both sides necessitating surgical drainage, after which complete recovery occurred. In all other patients the wounds healed primarily. No patients, treated with or without fasciotomy, showed signs of muscle hernia. No subcutaneous hematoma formation nor signs of nerve damage were found.
All 16 ulcers still open at the time of operation healed within 2 months (mean: 34 days; range: 21 - 55 days). During a mean follow-up of 3.9 (range: 2 - 5) years only one out of 38 patients (2.5%) developed a recurrent ulcer, 2 year after operation.

Discussion

Adequate ambulatory compression therapy achieves healing of most venous ulcers, but recurrence is frequent and has been reported to affect up to 49 per cent of patients at 3 months[21] and 22-69% at 1 year after healing[21,22]. Negus and Friedgood showed a recurrence rate of only 15% in a 6-year study of 109 ulcerated legs after ligation of incompetent perforating veins through a postero-medial approach[7]. The present study showed a recurrence rate of only 2.5% after a mean follow-up of 3.9 years, 39 of 40 extremities of patients who had active ulceration or healed ulceration remained healed. The patient who developed a recurrent ulcer had an active ulcer at the time of operation which healed within 4 weeks. This was a patient with associated deep vein incompetence by ultrasonography.

Conventional operative approaches to ligate incompetent perforating veins require long incisions, often through highly atrophic and poorly nourished skin and subcutaneous tissues, and are frequently associated with delayed wound healing, skin necrosis and wound infection[7,14,23]. To overcome these wound problems Edwards devised a phlebotome[24]. This instrument is introduced under the fascia some distance from the area of lipodermatosclerosis and sheares off all perforating veins. The disadvantages of this technique are that it is a blind method and painful subfascial hematomas occur. Subfascial endoscopy combines the advantage of Edwards introduction site and treatment under direct visual control. Our 7.5% wound complication rate is low and is comparable with the findings of Jugenheimer et al. who reported 3% delayed wound healing and 6% subcutaneous hematomas after endoscopic treatment of 72 patients with primary varicosis[25]. A mediastinoscope is present in most operating rooms and obviates the need to purchase special instruments.
In conclusion, subfascial ligation of incompetent perforating veins by use of a mediastinoscope is a fast and easy surgical procedure with a low complication rate which allows early ambulation and good cosmesis, with a low rate of recurrent of venous ulceration.

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5

ENDOSCOPIC VERSUS OPEN SUBFASCIAL DIVISION OF INCOMPETENT PERFORATING VEINS IN THE TREATMENT OF VENOUS LEG ULCERATION; A RANDOMIZED TRIAL

E.G.J.M. Pierik, H. van Urk[1], W.C.J. Hop[2], and C.H.A. Wittens

Department of Surgery, Sint Franciscus Gasthuis, Rotterdam, The Netherlands
[1]Department of Surgery, Vascular Unit, University Hospital Rotterdam-Dijkzigt, Rotterdam, The Netherlands
[2]Department of Biostatistics, Erasmus University Rotterdam, The Netherlands.

(submitted)

Summary

Background: Subfascial division of incompetent perforating veins plays an important role in the surgical treatment of patients with venous ulceration of the lower leg. To minimize the high incidence of postoperative wound complications with open exploration, recently endoscopic approaches have been developed. We carried out a prospective, randomized comparison of "open" and "endoscopic" treatment of these patients aimed at ulcer healing and postoperative wound complications.
Methods: Patients with current venous ulceration on the medial side of the lower leg were randomly allocated to open exploration by the modified Linton approach or endoscopic exploration by use of a mediastinoscope.
Findings: 39 patients were randomized, 19 to the open and 20 to the endoscopic exploration. The incidence of wound infections after open exploration was 53%, compared with 0% in the endoscopic group ($p < 0.001$). The open group needed longer hospital stays (mean 4 (range 2-6) versus 7 (3-39) days, $p = 0.001$). Four months after operation the ulcers of 17 patients (90%) in the open and 17 patients (85%) in the endoscopic group had healed. During a mean follow-up of 21 (range: 16-29) months no recurrences were noticed in either group.
Interpretation: Endoscopic division of incompetent perforating veins is equally effective as is open surgical exploration for the treatment of venous ulceration of the lower leg, but leads to significantly less wound healing complications. Endoscopic division is therefore the preferred method.

Introduction

Chronic venous ulceration of the leg is a common clinical problem affecting about 1-2% of the Western population[1]. Although almost all venous ulcers can be treated by simple conservative means, in the Lothian and Forth Valley survey, 66% of 600 patients studied had suffered one or more recurrences of venous ulceration over a 5-year period[2]. Surgical ligation of incompetent perforating veins of the lower leg in the treatment of venous ulceration has been reported as giving good long term results with respect to ulcer healing[3-6]. These operations decree a full exploration of the subfascial space which necessitates long incisions often through compromised cutaneous and subcutaneous layers.

As a consequence, postoperative wound complications are frequently noticed, discouraging wide application of this technique.
Recently, minimally invasive approaches have been developed which permit subfascial endoscopic interruption of incompetent perforating veins in patients with venous ulceration with promising results concerning ulcer healing and postoperative morbidity[7-10]. No comparative studies have been carried out between "open" and "endoscopic" subfascial explorations.
This study reports the results of the first prospective randomized trial of endoscopic versus open subfascial exploration of the lower leg in patients with chronic venous ulceration aimed at ulcer healing and postoperative wound complications.

Patients and methods

All patients with current venous ulceration on the medial aspect of the lower leg who were referred to the Department of Surgery of the Saint Franciscus Hospital in Rotterdam from February 1994 were considered for entry into the study. The study was approved by the hospital medical ethics committee and in all cases informed consent was obtained. Patients were randomly allocated to either open or endoscopic surgery by opening sealed envelopes.
Patients were stratified for presence or absence of superficial venous incompetence, for primary or recurrent ulceration and for presence or absence of diabetes mellitus.
A power calculation before the study indicated that with expected wound complication rates of 40% for open[11,12] and 10% for endoscopic perforantectomy[10,13] respectively it would be necessary to include 47 patients in each limb of the study (two-sided; alpha = 0.05; beta = 0.10). Fisher's exact test was used to assess differences in proportions; the Mann-Whitney test was used to assess differences in hospital stay.
The age, gender, duration of the present ulcer period, primary or recurrent ulceration and size of the ulcer of each patient were documented. All patients underwent investigation of their venous status by physical examination and duplex ultrasonography before and 6 weeks after operation. Concomitant superficial venous incompetence was treated by flush saphenofemoral ligation and limited stripping of the long saphenous vein from groin to just below knee level.

Exclusion criteria were an ankle/brachial arterial pressure index of less than 0.8 or previous surgical subfascial exploration of the same leg.
All patients received 1.5 g cefuroxime intravenously before operation. Open subfascial exploration was performed by the modified Linton approach[14] and endoscopic subfascial exploration was performed by use of a mediastinoscope as described in detail elsewhere[15]. All perforating veins on the medial and dorsal side of the lower leg were interrupted by the use of hemoclips (Ligaclip, Ethicon Endosurgery, Johnson & Johnson, U.S.A.). At the end of the operation, the deep fascia was left open and the skin was closed by staples. The time taken for each operation was recorded as the time between first incision and skin closure. Patients were mobilized on the first postoperative day and treated by ambulant compression therapy (Comprilan, Beiersdorf medical, the Netherlands) until the ulcer had healed. Elastic stockings (Elvarex, Beiersdorf medical, the Netherlands) were prescribed indefinitely when associated deep venous incompetence was present. The length of hospital stay was registered. Each patient returned to the outpatient clinic at 1, 2, 6, 12, 24 and 52 weeks after operation. Wound healing and ulcer healing were described separately and in detail. Wound infections were divided into superficial and deep incisional surgical site infections and classified according to the latest definitions for nosocomial surgical site infections of the Centers for Disease Control[16].

Results

For fear of unexpectedly high and severe morbidity after the modified Linton procedure as compared to the endoscopic procedure, during the trial an unplanned interim-analysis was considered and performed in April 1995 (15 months after the beginning of the study). Of the thirty-nine patients included at that moment, 20 had been randomized for endoscopic and 19 for open exploration of the subfascial area. The interim-analysis confirmed our presumption and showed a highly significant ($p < 0.001$) difference in wound complication rate to the detriment of open exploration. It was decided that it was not ethically acceptable to continue inclusion of patients in the trial. As a consequence, the intake of patients was stopped and follow-up of included patients continued.
Table 1 shows the postoperative complications in both groups. In the open group superficial wound infection occurred in 3 patients and deep wound infection in 7 patients in contrast to zero infections in the endoscopic group ($p = 0.003$). Two

patients in the open group complained of dysesthesia in the area of distribution of the saphenous nerve.

Table 1. Postoperative wound complications after open and endoscopic division of perforating veins.

	Open perforantectomy (n=19)	Endoscopic perforantectomy (n=20)	Statistical significance
Wound infection	10 (53%)	0 (0%)	$p<0.001$
superficial	3 (16%)	0 (0%)	$p=0.11$
deep	7 (37%)	0 (0%)	$p=0.003$
Nerve injury	2 (11%)	0 (0%)	$p=0.23$

Table 2. Patient characteristics. Data given are numbers of patients or mean (range).

	Open perforantectomy (n=19)	Endoscopic perforantectomy (n=20)
Age (years)	70 (36-89)	64 (33-89)
Sex ratio (M/F)	3/16	9/11
Diabetes Mellitus	1	0
Recurrent ulceration	12	13
Duration of present ulcer period (days)	249 (14-1825)	299 (20-3650)
Total duration of ulceration (months)	140 (9-480)	148 (11-600)
Duplex findings preoperatively:		
superficial incompetence	13	14
deep incompetence	14	11
incompetent perforating veins	2.1 (1-5)	2.3 (1-5)

Both randomized groups appeared well matched regarding various characteristics (Table 2). By chance there was a distinct predominance of females in the open group in comparison with the endoscopic group. However, no difference was found between males and females regarding infection rates in either treatment group. In the open perforantectomy group the wound infection rate was 67% for males as compared to 56% for females (p = 1.0), while both rates were 0% in the endoscopic group.
All patients had one or more incompetent perforating veins on preoperative duplex ultrasonography. The number and distribution of incompetent perforating veins were comparable in both groups (Table 2). More than half of the patients in both groups had deep vein incompetence on duplex ultrasonography. In all patients one or more prolonged attempts at conservative treatment had been carried out. Table 3 summarizes the operative results in both groups.

Table 3. Operation data and clinical results. Values in parentheses are ranges. NS = not significant.

	Open perforantectomy (n=19)	Endoscopic perforantectomy (n=20)	Statistical significance
Mean operating time (min)	41 (19-70)	43 (20-90)	NS
Mean blood loss (ml)	170 (30-300)	43 (10-150)	$p<0.001$
Number of perforating veins found at operation	3.0 (1-6)	2.9 (1-6)	NS
Hospital stay (days)	7 (3-39)	4 (2-6)	$p=0.001$
Readmission	2	0	NS
Healing rate	90%	85%	NS
Recurrences	0	0	-

The mean operating time for the endoscopic group was similar to that in the open group. Mean blood loss was 170 ml in the open and 43 ml in the endoscopic group ($p<0.001$). The mean number of perforating veins found at

operation was the same for both groups (3.0 versus 2.9). There were no intraoperative complications.
Follow-up was complete in all patients. The mean hospital stay in the endoscopic group was 3 days shorter than in the open group ($p=0.001$). Two patients in the open group were readmitted to the hospital because of severe wound complications necessitating reoperation and/or intravenous antibiotics. One elderly patient randomized to endoscopic surgery died 5 months after operation from a myocardial infarction. Postoperative duplex ultrasonography after 6 weeks showed no signs of superficial or perforator incompetence in the open group. In four patients of the endoscopic group 4 persisting and 2 recurrent perforating veins were found without signs of superficial incompetence. Four months after operation the ulcers of 90% (17/19) of patients in the open group had healed, which was similar to the 85% (17/20) in the endoscopic group. No recurrences of venous ulceration were found during a mean follow-up of 21 months (range: 16-29) (Table 3).

Discussion

Venous ulceration is a common cause of serious disability. While almost any venous ulcer can be healed with bed rest and elevation of the limb, keeping it healed frequently requires repeated hospitalization and surgery. Delayed wound healing, skin necrosis and wound infection are a frequent and serious sequel of open surgical explorations of the subfascial area in order to ligate incompetent perforating veins. In search for less invasive approaches, new endoscopic techniques have been developed during the last decade. With these techniques postoperative pain seems minimal and mobilization of the patient can commence immediately after operation, allegedly reducing morbidity caused by postoperative immobilization. However, up until now, no randomized studies have been carried out directly comparing the two approaches for ulcer cure and wound healing.
In this prospective study, 53% of patients treated with open perforantectomy had their postoperative course complicated by wound infections. Although some authors report wound complications in only 7-24% of cases[6,17-19], our findings are in concordance with other reports of surgical treatment of patients with venous leg ulceration, mentioning wound complication rates of 44-58%[11,12,20,21].

Our wound infection rates were based on clearly stipulated criteria for the definition of wound infection[16] and a complete follow-up in all patients. The importance of definition and post discharge wound surveillance for the adequate documentation of wound infections has recently been corroborated[22]. The lacking of this as well as retrospective study designs may partly explain the low infection rates after open perforantectomy reported by some authors[6,17-19].
Endoscopic exploration of the subfascial area in patients with venous ulceration resulted in uncomplicated primary healing of all wounds in this study. Wound complications after endoscopic perforantectomy have been reported in 0-7.5% in retrospective studies[9,10,13,23,24]. In contrast to Fischer[23] and Jugenheimer[13] we did not notice any nerve injury after endoscopy. Considering the more superficial position of the posterior tibial artery and vein and the tibial nerve in the most distal part of the lower leg care must be taken not to confuse these structures with perforating veins. We advocate that structures, especially in the lower third of the leg, only are divided after identification as perforating veins for a certainty[15]. An incompetent perforator exhibits a tortuous or dilatated vein which passes the subfascial space transversely and penetrates the fascia. Besides, we agree with Fischer to caution against the use of electrocautery in the subfascial area during endoscopy[23] and prefer clipping and division of perforating veins.

Our endoscopic method of identification and interruption of incompetent perforating veins requires a small incision on the medial side of the lower leg only. This is based on the fact that 90% of incompetent perforating veins occur in the dorsomedial area of the lower leg (posterior arch vein distribution)[25] and the knowledge that these are the most important perforators in the pathogenesis of skin changes[26].
Healing rates of more than 80% in both groups in our study support the concept of meticulously eradicating reflux at all potential sites of deep to superficial reflux in the surgical treatment of venous ulceration of the lower leg[5,27]. Although our follow-up period is relatively short, the complete absence of recurrences in our study supports the importance of continued ambulant compression therapy in patients with any associated deep venous insufficiency[6,28] and does not support the view of Bradbury et al. that perforator and saphenous ligation alone does not lead to permanent ulcer healing in the presence of deep venous reflux[29,30]. Burnand et al. found recurrent ulceration after surgical treatment in all their patients who had evidence of deep-vein damage on ascen-

ding phlebography, on average manifesting 17 months after operation[31]. In his retrospective study, however, no mention is made about the postoperative management and his follow-up data are incomplete. Although more than half of our patients had deep venous incompetence on preoperative duplex ultrasonography, after completion of minimally 12 months follow-up in all patients no recurrent ulcers were noted. Although a longer follow-up of our patients is needed before definitive conclusions can be drawn, a possible explanation can be found in our conscientious postoperative ambulant compression therapy until ulcers are healed and thereafter prescription of elastic stockings in every patient with associated deep venous incompetence. The same combined treatment strategy led to good or excellent results in venous ulcer patients reported by others[5,21,32].

In the last decade, there is a clear trend toward less invasive procedures in general and vascular surgery. Endoscopic exploration of the subfascial area through a small incision offers little discomfort to the patient. Our study shows that, compared to open exploration, incompetent perforating veins can be detected and interrupted with minor incisional trauma and with less blood loss. Presumably, reduction in postoperative pain and disability, early mobilization and above all a significant reduction in the incidence of wound healing complications, all lead to a significantly shorter hospital stay and fewer readmissions than open surgical exploration. We conclude that endoscopic division of incompetent perforating veins is superior to open surgical exploration of the subfascial space in patients with venous ulceration of the lower leg. This minimal invasive procedure in combination with ligation of the saphenofemoral junction and continued compression therapy allows uncomplicated wound healing and a high ulcer healing rate in patients with chronic venous incompetence and makes the Linton procedure for these patients obsolete.

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6

VALIDATION OF DUPLEX ULTRASONOGRAPHY IN DETECTING COMPETENT AND INCOMPETENT PERFORATING VEINS IN PATIENTS WITH VENOUS ULCERATION OF THE LOWER LEG

E.G.J.M. Pierik, I.M. Toonder, H. van Urk[1], and C.H.A. Wittens

Department of Surgery, Sint Franciscus Gasthuis, Rotterdam, The Netherlands
[1]Department of Surgery, Vascular Unit, University Hospital Rotterdam-Dijkzigt, Rotterdam, The Netherlands.

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Abstract

Purpose: Incompetent perforating veins play an important role in the etiologic mechanism of venous ulceration and recurrent varicose veins. The anatomic and functional status of the venous system can be evaluated by duplex ultrasonography. To determine the value of this technique in the identification of competent and incompetent perforating veins, a prospective study was performed.
Methods: In patients who underwent a subfascial exploration for venous ulceration of the lower leg, the preoperative findings of duplex ultrasonography were compared with the findings at surgical exploration.
Results: In 20 consecutive patients, 42 incompetent and 8 competent perforating veins were detected by duplex ultrasonography. During operation the location of all 50 perforating veins appeared to be predicted correctly. Eleven additional perforating veins were found during operation, undetected by duplex ultrasonography. The sensitivity and specificity of duplex ultrasonography in predicting the site of perforating veins at the medial side of the lower leg in our study was 79.2% and 100%, respectively, for incompetent perforating veins and 82% and 100% for competent and incompetent perforating veins.
Conclusion: These figures indicate that duplex guided local exploration of the lower leg in patients with venous ulceration due to incompetent perforating veins would miss a substantial number of perforating veins, possibly leading to incomplete healing or recurrent ulceration.

Introduction

Knowledge of the distribution and exact localization of incompetent perforating veins of the lower leg is important in the treatment of (recurrent) varicose veins and venous ulceration[1-7]. The recent development of duplex ultrasonography (B-mode real-time ultrasound imaging combined with pulsed Doppler ultrasonography), especially with bi-directional colour flow mapping, provides a simple, repeatable, and noninvasive instrument for the study of the venous system and numerous reports have shown its usefulness in the evaluation of patients with chronic venous insufficiency[8-13]. This technique has the advantage of providing detailed anatomical information regarding the nature of the venous pathological condition and in particular is capable of discriminating competent veins from

incompetent veins. In some centers duplex ultrasonography is regarded as the gold standard for the diagnosis of venous disease[14,15]. However, studies concerning validation of duplex investigation of perforating veins can be faulted for having a poorly standardized protocol, mixed study populations, small numbers of patients or unjustly considering ascending or descending phlebography as gold standard[9,16-20].
This study was undertaken to determine, in a prospective way, the sensitivity and specificity of duplex scanning with colour-flow imaging in the identification of competent and incompetent perforating veins of the lower leg compared to the operative findings during a modified Linton procedure (regarded as the gold standard for evaluating the perforator system of the medial side of the lower leg)[3] in patients with actual venous stasis ulceration.

Patients and methods

The series comprises 20 consecutive patients, 4 men and 16 women, mean age 70.4 years (range: 36-89 years), who underwent a modified Linton procedure for venous ulceration of the lower leg between 1st January 1994 and 1st March 1995 at the Sint Franciscus Gasthuis in Rotterdam. The study was approved by the hospital medical ethics committee and in all cases informed consent was obtained. All patients suffered chronic venous insufficiency graded class 6 according to the classification of the Society for Vascular Surgery and the International Society for Cardiovascular Surgery[21]. None of the patients had an arterial component to their ulceration as determined by clinical examination and a resting arterial Doppler ankle-brachial pressure index >0.8.
Patterns of venous insufficiency were determined by colour-flow duplex ultrasonography by an experienced vascular technologist before operation and 6 weeks postoperatively. All measurements were made using a linear array transducer with a 7.5 MHz imaging/5 MHz pulsed-wave Doppler colour-flow duplex system (P700, Philips Medical Systems, Eindhoven, the Netherlands) with the patient in a near upright standing position.
Perforator vein evaluation began by tracking the posterior tibial veins and posterior arch vein and picking up the perforating veins as they issue forth from this. Attention was then directed to the rest of the calf where the entire medial and posterior aspects were evaluated as described by Hanrahan et al[9]. Perforating veins were defined as vessels that penetrate the fascia and constitute

continuously traceable connections between the superficial and deep venous systems. The only criterion for insufficiency was reverse venous flow (greater than 0.3 seconds)[22] demonstrated on the Doppler spectral display during the relaxation phase after active dorsiflexion of the ankle and/or manual compression of the foot. A sterile conductivity gel and transparant dressing were used for the duplex evaluation of the ulcer bed[9]. The number, localization and insufficiency of the perforating veins at the medial side of the lower leg were noted. The distance of each perforating vein to the sole of the foot was measured in centimeters.
Subfascial ligation of perforating veins by medial access (modified Linton procedure) was performed under spinal anaesthesia and without tourniquet control. With the patient in a slight Trendelenburg position, a longitudinal incision was placed medially and extended from the subgeniculate area near the condyles downward through the ulcer to the medial malleolus. The incision extends through the skin, subcutaneous tissue and crural fascia, avoiding subcutaneous dissection. The dissection continues in the subfascial plane anteriorly up to the anterior edge of the tibia and posteriorly up to the midline. All medial perforators were identified, ligated and divided. Number and localization were registered and the distance to the sole of the foot was measured. In addition, patients with saphenofemoral incompetence or incompetence of the long saphenous vein on duplex ultrasonography underwent flush saphenofemoral ligation and stripping of the long saphenous vein from groin to a level just below the knee.
An incompetent perforating vein was judged to be correctly predicted by duplex ultrasonography if it was within 1.5 cm of the site of a perforating vein found at surgery. Number and localization of perforating veins detected with duplex ultrasonography were evaluated for sensitivity and specificity.

Results

In 20 patients 42 incompetent perforating veins were found on the medial side of the lower leg by preoperative duplex ultrasonography (range: 1 - 5; mean: 2.1). In 6 patients 8 competent perforating veins were detected. The location of the perforating veins is given in Table 1. Concomitant superficial and deep venous incompetence was present in 14 and 15 patients respectively.

During operation a total of 61 perforating veins were detected and ligated (range: 1 - 6; mean: 3.05). The site of all 42 incompetent and 8 competent perforating veins was predicted correctly by duplex ultrasonography preoperatively. No false-positives were detected at operation. During subfascial exploration of the medial side of the lower leg, however, 11 additional perforating veins were detected in 8 patients which were not visualised preoperatively. Four of these veins had a diameter of more than 3 mm. The distribution of the eleven false-negatives for duplex ultrasonography is given in Table 1.

Table 1. Number and location of incompetent, competent and false-negative perforating veins on the medial side of the lower leg during preoperative Duplex ultrasonography (in cm above the sole of the foot).

Location (in cm)	Incompetent veins	Competent veins	False-negative veins
0 - 5	1	0	2
6 - 10	3	1	4
11 - 15	11	2	3
16 - 20	13	2	1
21 - 25	7	1	1
26 - 30	5	2	0
31 - 35	2	0	0
36 - 40	0	0	0
Total	42	8	11

All 20 patients completed follow-up and appeared for examination 6 weeks after surgery. No perforating vein could be found in any patient at duplex ultrasonography. Three months after the operation the ulcers of 17 of 20 patients had healed.

In relation to the findings at operation, the sensitivity of duplex ultrasonography in predicting the site of incompetent perforating veins in patients with venous

ulceration of the lower leg is 79.2% and the specificity 100%. The sensitivity and specificity of duplex ultrasonography in our study in predicting the site of (competent and incompetent) perforating veins is 82% and 100% respectively.

Discussion

Numerous reports have supported the importance of perforating vein incompetence in the aetiology of persistent and recurrent varicose veins and venous ulceration of the lower leg[9,23-25]. Surgical ligation of these incompetent perforating veins has been reported as giving good long term results but, because of the absence of predilection sites[26] and difficulties in accurate preoperative localisation[3], this usually necessitated subfascial surgical explorations through long incisions, frequently associated with postoperative necrosis of the wound margins or delayed wound healing[27].
The recent development of duplex ultrasonography allows for a detailed evaluation of the anatomical and functional status of the perforating system as well as the deep and superficial systems[9]. As a consequence, duplex guided ligation of incompetent perforating veins through multiple small local incisions in the natural skin lines has been advocated[20].
However, to our knowledge, no prospective study comparing the location of incompetent perforating veins found at duplex ultrasonography and the findings of a thorough surgical exploration of the lower leg in a homogeneous group of patients has been reported. We have used the full surgical exploration of the medial side of the lower leg in patients surgically treated for their venous ulcers as gold standard for calculation of the sensitivity and specificity of duplex ultrasonography in detecting perforating veins in these patients. The complete absence of perforating veins on duplex ultrasonography 6 weeks postoperatively in all our patients confirms the thoroughness of this procedure. The prevalence of perforating veins in our study coincides well with previously published reports of operated patients with venous ulceration[5,28,29].
Having an excellent specificity, duplex ultrasonography did miss, however, one or more perforating veins on the medial side of the lower leg in 40% of the patients in this study. Several explanations can account for these false-negatives. The transmission of the ultrasound beam in this group of patients might be hampered by the venous ulcer and area of lipodermatosclerosis, as reported by others[30] or by the preceding use of zinc paste. This may explain why over 60%

of the false-negative veins were found between 6 to 15 cm above the sole of the foot which is the anatomical area most likely to be involved by ulceration. Secondary, some inaccuracies of duplex ultrasonography can be explained by the fact that some perforating veins found at operation were in close contact to the medial crest of the tibia, an area visualized with difficulty by duplex ultrasonography. Finally, perforating vessels smaller than 1 mm in diameter, especially when they are competent, are not visualized easily with duplex ultrasonography and it is difficult to assess flow and direction of flow within them[10]. Although it is questionable whether these last perforating veins contribute significantly to the disease process, we believe that the number of false-negatives in our study does have important therapeutic consequences. In patients suffering from venous ulceration or recurrent varicose veins, for which ligation of all incompetent perforating veins is the only definitive treatment, a full surgical exploration would appear to be the only certain approach. Because all false-negative perforating veins were found between 0 and 25 cm. from the sole of the foot, it could be argued that local exploration through small, duplex guided incisions will suffice only in the upper third of the lower leg.

In conclusion, the results of this study demonstrate duplex ultrasonography to be an important noninvasive modality for the identification of perforating veins in patients with venous leg ulcers. Its relatively low sensitivity of only 79.2%, however, argues for a complete subfascial exploration of the lower leg during operation in patients with venous ulceration due to incompetent perforating veins instead of local exploration guided by preoperative duplex ultrasonography only. To minimize the postoperative wound complications notoriously associated with direct surgical exploration, new endoscopic approaches have been developed recently to explore the entire subfascial space, avoiding the necessity of a long skin incision[29,31].

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7

EFFICACY OF SUBFASCIAL ENDOSCOPY IN ERADICATING PERFORATING VEINS OF THE LOWER LEG AND ITS RELATION WITH VENOUS ULCER HEALING

E.G.J.M. Pierik, H. van Urk[1], and C.H.A. Wittens

Department of Surgery, Sint Franciscus Gasthuis, Rotterdam, The Netherlands
[1]Department of Surgery, Vascular Unit, University Hospital Rotterdam-Dijkzigt, Rotterdam, The Netherlands.

(submitted)

Abstract

Purpose: The purpose of this study was to investigate the efficacy of subfascial endoscopy by use of a mediastinoscope in the identification and ligation of incompetent perforating veins in patients with venous ulceration of the lower leg.
Methods: All patients who underwent subfascial endoscopy for venous ulceration between 1st January 1994 and 1st March 1995 at the Sint Franciscus Gasthuis in Rotterdam underwent duplex ultrasonography of the lower leg before and 6 weeks after operation. The number and localization of the perforating veins on the medio-dorsal side were compared with the findings during subfascial endoscopy.
Results: In 20 patients preoperative duplex examination showed 46 incompetent and 6 competent perforating veins. During operation the site of 43 incompetent and all competent perforating veins was confirmed. Five additional perforating veins were found at operation (false-negatives). Postoperative duplex ultrasonography showed 6 incompetent perforating veins (4 persisting and 2 recurring perforators) in 4 patients of which the ulcers did not heal in three. The ulcers of the other 17 patients healed.
Conclusions: Subfascial endoscopy is an efficient technique in identifying incompetent perforating veins in patients with chronic ulceration of the lower leg. The persistence of incompetent perforating veins is related to failure of ulcer healing.

Introduction

Subfascial endoscopic identification, bipolar coagulation and division of incompetent perforating veins in patients with chronic venous insufficiency was first introduced by Hauer in 1985[1]. A small incision, outside the area of trophic changes and induration of skin and subcutaneous tissue, allows interruption of perforating veins under direct vision with minimal morbidity. In line with the current trend towards minimally invasive surgery, a growing number of studies has been published reporting encouraging results with this approach in patients with primary varicosis, lipodermatosclerosis and venous ulceration of the lower leg[2-7]. However, all these studies were retrospective in design and focused

mainly on clinical outcome in terms of newly formed varicosities, ulcer healing and wound complications.
Notwithstanding enthusiastic reports, failure of the ulcer to heal or recurrence of ulceration after endoscopic treatment of incompetent perforating veins in patients with venous ulcers of the lower leg is reported in 2.5-11%[6-9]. At the same time, persistent or recurrent incompetent perforating veins have been found in 1-4% after endoscopic exploration of the subfascial area[3,6,10]. It can be hypothesized that this may be caused by limited accessibility of perimalleolar perforating veins in patients with far-advanced changes of lipodermatosclerosis of the skin which do not allow considerable manoeuvrability of endoscopic instruments. Others have postulated, especially in the presence of deep venous incompetence, the possibility of new channels opening up between the deep veins and the adjacent skin, leading to recurrence of ulceration[11]. Potentially, this could occur through the dilatation of small caliber perforators, missed at the time of surgery, or through true neovascularization.
The present prospective study was undertaken to investigate the efficacy of subfascial endoscopy in eradicating perforating veins in patients with venous ulceration and to examine a possible relation between persistent incompetent perforating veins and disturbed ulcer healing.

Patients and methods

The series comprises all consecutive patients who underwent a subfascial endoscopy for venous ulceration of the lower leg (as part of a prospective, randomized trial comparing open and endoscopic perforantectomy) between 1st January 1994 and 1st March 1995 at the Sint Franciscus Gasthuis in Rotterdam. The study was approved by the hospital medical ethics committee and in all cases informed consent was obtained. All patients suffered chronic venous insufficiency graded class 6 according to the classification of the Society for Vascular Surgery and the International Society for Cardiovascular Surgery[12]. None of the patients had an arterial component to their ulceration as determined by clinical examination and a resting arterial Doppler ankle-brachial pressure index >0.8.
Patterns of venous insufficiency were determined by color-flow duplex ultrasonography by an experienced vascular technologist before operation and 6 weeks postoperatively. All measurements were made using a linear array

transducer with a 7.5 MHz imaging/5 MHz pulsed-wave Doppler color-flow duplex system (P700, Philips Medical Systems, Eindhoven, the Netherlands) with the patient in a near upright standing position.
Perforating veins were defined as vessels that penetrate the fascia and constitute continuously traceable connections between the superficial and deep venous systems. The only criterion for insufficiency was reverse venous flow demonstrated on the Doppler spectral display during the relaxation phase after active dorsiflexion of the ankle and/or manual compression of the foot[13]. Insufficiency was determined to be present if reverse flow persisted for longer than 0.3 seconds. A sterile conductivity gel and transparent dressing were used for the duplex evaluation of the ulcer bed[14]. The number, localization and presence or absence of insufficiency of the perforating veins at the medial and dorsal side of the lower leg were noted. The distance of each perforating vein to the sole of the foot was measured in centimeters.

Endoscopic subfascial identification and ligation of perforating veins was performed under spinal anaesthesia and without tourniquet control. We made use of a mediastinoscope and clipping instrument as previously described in detail[15]. All medial and dorsal perforators that could be found were ligated and divided. Number and localization were registrated and the distance to the sole of the foot was measured. In addition, patients with saphenofemoral incompetence or incompetence of the long saphenous vein on duplex ultrasonography underwent flush saphenofemoral ligation and stripping of the long saphenous vein from groin to a level just below the knee.
Following operation, patients were mobilized on the first postoperative day and treated by ambulant compression therapy using short-stretch bandages (Comprilan, Beiersdorf medical, the Netherlands) until the ulcer was healed. When ulcers were healed elastic stockings (Elvarex, Beiersdorf medical, the Netherlands) were prescribed indefinitely when associated deep venous incompetence was present. After hospital discharge all patients were seen at the outpatient clinic at 1, 2, 6, 12, 26 and 52 weeks after operation.
A perforating vein found at surgery was judged to be identical as a preoperative or postoperative localized vein if it was found within 1 cm. of the site determined at preoperative or postoperative duplex ultrasonography, respectively.

Results

Twenty patients, 9 men and 11 women, mean age 64 years (range: 33-89 years), underwent subfascial endoscopy for venous ulceration of the lower leg. In these patients 46 incompetent perforating veins were found on the medio-dorsal side of the lower leg by preoperative duplex ultrasonography (range per patient: 1-5; mean: 2.3). Six competent perforating veins were detected in 5 patients. The localization is given in Table 1. At preoperative duplex ultrasonography, concomitant superficial venous incompetence was present in 14 patients. Associated incompetence of the deep venous system was noted in 11 patients.

Table 1. Number and localization of competent and incompetent perforating veins on the medio-dorsal side of the lower leg during preoperative duplex ultrasonography, subfascial endoscopy and postoperative duplex ultrasonography.

Distance from the sole of the foot	Preoperative duplex		Subfascial endoscopy			Post-operative duplex
	Incompetent	Competent	Confirmed	Missed	False-negatives	Incompetent
0-5 cm	2	0	1	1	0	1
6-10 cm	4	0	2	2	0	3
11-15 cm	13	2	15	0	1	2
16-20 cm	13	3	16	0	2	0
21-25 cm	8	1	9	0	2	0
26-30 cm	4	0	4	0	0	0
31-35 cm	1	0	1	0	0	0
36-40 cm	1	0	1	0	0	0
Total	46	6	49	3	5	6

During subfascial endoscopy a total of 54 perforating veins were identified and clipped (range 1-6; mean: 2.9). The site of 43 incompetent and all 6 competent perforating veins could be confirmed during operation (Table 1). Three incompetent perforating veins in two patients could not be identified during subfascial endoscopic exploration. On the other hand, 5 additional perforating veins in 4 patients were detected and clipped during exploration which were not visualized by duplex ultrasonography preoperatively (false-negatives). The distribution of the missed and false-negative perforating veins is also found in Table 1.

All patients completed follow-up. Six weeks after surgery, in 4 patients 6 incompetent perforating veins were found at duplex ultrasonography (Table 1). Two patients were the same in whom the three preoperatively diagnosed perforating veins could not be confirmed at operation. The localization of these veins was similar to the preoperative duplex examination. The ulcers of both patients did not heal. In one patient 2 'new' incompetent perforating vein were detected. This patient suffered more than 45 years from venous ulceration with multiple recurrences on both legs, based on combined deep and superficial venous incompetence. His ulcer did not heal although initial improvement in the size of the ulcer was achieved. Six months after operation a squamous cell carcinoma was diagnosed in his ulcer. In the fourth patient a perforating vein was detected at the same level as was seen preoperatively and at endoscopy. In spite of this, his ulcer healed uneventful after 5 weeks. In the other 17 patients no persistent or recurrent perforating veins could be detected at postoperative duplex ultrasonography. Four months after subfascial endoscopy the ulcers of 17 patients had healed. During a minimal follow-up of 12 months in all patients, no recurrences of venous ulceration were noticed. Nine of these 17 patients did have concomitant deep venous incompetence.

Discussion

Incompetent perforating veins are found in 70-100 per cent of patients with venous ulceration[16-18]. The endoscopic subfascial division of perforating veins is a useful and safe procedure in the treatment of patients with end-stage chronic venous insufficiency[3,7,9]. A potential limitation of the technique includes the inability to reach all perforating veins. Especially in patients with severe

lipodermatosclerosis the necessary expansion of the subfascial space can be laborious[9]. The advantage of the use of a mediastinoscope is that full view of the subfascial space after introduction of the scope under the fascia is easily maintained by its rigid shape.
In our study, in 17 of 20 patients all existing perforating veins could be identified and divided by subfascial endoscopy. Six weeks after subfascial endoscopy only 4 persisting incompetent perforating veins were found at duplex ultrasonography. Three incompetent perforating veins in two patients, detected at preoperative and postoperative duplex ultrasonography, could not be identified at surgery. A possible explanation could be their subfascial course in the septum intermusculare medialis which sometimes obscures incompetent perforators[10]. At present, we routinely incise this fascia endoscopically when present.
The persisting incompetent perforating vein of the patient in whom during endoscopy this vein apparently was identified may be the result of an erroneously placed or dislodged clip.

In one patient two recurring incompetent perforating veins were found during postoperative duplex ultrasonography. Possibly, in this patient the incompetent perforating veins were the result of severe underlying deep venous insufficiency. Wilson et al. described a distinct group of patients who suffered persistent ulceration despite conventional and perforating vein surgery combined with graduated compression hosiery[18]. They had grade 3-4 deep reflux on descending phlebography with grossly abnormal calf pump function after surgery. It could be that these patients will benefit more from surgical correction of their underlying severe deep venous incompetence by venous valve surgery[18]. Up until now, however, no preoperative investigation exists which will discriminate these patients from patients who will benefit from eradicating all sites of venous reflux in the superficial and perforator system.
We found a healing rate of 85% (17/20 ulcers) after endoscopic ligation, with no recurrences during a follow-up of 1 year. This is in accordance with the experience of others who performed endoscopic ligation of perforating veins. Jugenheimer and Junginger, also using a single port technique, observed healing of 94% (16/17) of limbs that had ulceration[3]. In a retrospective analysis of 110 patients, Gloviczki et al. reported ulcer healing in 78% and ulcer recurrence in 6% of their patients, using standard laparoscopic equipment with CO_2 insufflation in more than half of the procedures[19].

In three patients, the ulcers did not heal after endoscopic surgery. In two of these patients one or more incompetent perforating veins were missed during operation. One of the most important factors in determining whether an ulcer will heal or not after surgery is the completeness of surgery to control venous reflux[20]. By clinical examination and phlebography, Cranley et al. found inadequate removal of incompetent veins to be the cause of failure in 20% of their patients after conventional surgical treatment[21]. The persistence of incompetent perforating veins after surgery is always considered a failure of the surgical technique. This probably can be hold responsible for the non healing in 2 of 3 patients in our study.

We conclude that subfascial endoscopic perforator surgery by use of a mediastinoscope is an effective approach to identify and ligate incompetent perforating veins in patients with venous ulceration of the medial side of the lower leg. The use of a single-port endoscope permits identification of nearly all perforating veins in patients with far advanced stages of chronic venous insufficiency. Exploration of the entire subfascial area, splitting of the septum intermusculare medialis when present and careful handling of the instruments seem important to prevent the persistence of incompetent perforating veins, which is in our study related to failure of ulcer healing.

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8

SUMMARY AND CONCLUSIONS

8.1 Summary and conclusions

Venous ulceration of the lower limb is generally acknowledged as the end stage of chronic venous insufficiency. The cause of venous insufficiency may be located in the superficial, the deep or the perforating venous system. Epidemiological studies have shown it to be a very common disorder affecting 1-2% of the population in the Western world. It can be estimated that annually in the Netherlands approximately 1.8 billion Dutch guilders is spent on the treatment of patients with venous ulceration of the lower leg. Although the majority of venous ulcers can be healed by conservative means of which ambulant compression therapy is the most important, many of these ulcers will recur. Good long term results with respect to ulcer healing have been reported by surgical treatment of these patients aimed at correction of the underlying incompetent superficial and perforating veins. These operations, however, necessitate long incisions and postoperative wound complications frequently occur. Since 1985, in line with the current interest in minimally invasive surgical techniques, subfascial endoscopic approaches have been developed to surgically interrupt incompetent perforating veins.

In *Chapter 1* subfascial endoscopic perforating vein surgery (SEPS) is introduced in the light of anatomical, epidemiological and socio-economic aspects of venous ulceration of the lower leg.

In *Chapter 2* a review is presented of the scientific literature about the surgical treatment of incompetent perforating veins. The development of subcutaneous, subfascial and ultimately endoscopic approaches is described subsequently.

The subfascial endoscopic approach of the lower leg and interruption of incompetent perforating veins by use of a mediastinoscope and a long clipping instrument is described in detail in *Chapter 3*. The importance of an accurate

knowledge of the surgical anatomy of the lower leg, the presence of the septum intermusculare medialis, the risk of missing incompetent perforating veins during SEPS and the existence of a learning curve are accentuated.

In a retrospective study the surgical treatment of 38 patients with chronic venous insufficiency in 40 legs were analyzed. All patients suffered recurrent or protracted venous ulceration and were treated by subfascial endoscopic ligation, using a mediastinoscope. Additional ligation and partial stripping of the long saphenous vein was performed when concomitant superficial venous incompetence was present. Sixteen patients had active ulceration at the moment of operation. All ulcers healed within 2 months after operation. Two patients developed a wound complication postoperatively. During a mean follow-up of 3.9 years only one patient developed a recurrent ulcer. It was concluded that subfascial endoscopic interruption of incompetent perforating veins by use of a mediastinoscope is a surgical technique with good results in patients with venous ulceration in terms of a high healing rate, a low recurrence rate and a low postoperative complication rate. The results of this study are presented in *Chapter 4*.

In *Chapter 5* the results are described of a prospective, randomized study comparing the results of the classic open subfascial exploration (modified Linton operation) versus the endoscopic subfascial exploration (by use of a mediastinoscope) in patients with venous ulceration of the lower leg. Concomitant superficial venous incompetence was treated by flush saphenofemoral ligation and partial stripping of the long saphenous vein. Postoperatively, all patients were treated by ambulant compression therapy. During the trial an unplanned interim-analysis was performed which showed a highly significant difference in postoperative wound complications between both groups. No wound complications were seen in 20 patients randomized for endoscopic exploration. Ten wound complications occurred in the group of 19 patients who were randomized to open exploration ($p < 0.001$). The number of perforating veins found at operation was the same in both groups (3.0 (range: 1-6) and 2.9 (range: 1-6), respectively). The 'open' group needed longer hospital stays than the 'endoscopic' group (mean 4 (range 2-6) versus 7 (range 3-39) days respectively, $p=0.001$). In both groups the ulcers of 17 patients healed within four months after operation. During a mean follow-up of 21 (range: 16-29) months no recurrences were noticed in these 34 patients. From

this study it was concluded that the endoscopic division of incompetent perforating veins is superior to open surgical exploration of the subfascial space in patients with venous ulceration of the lower leg. In the healing of ulceration both approaches are equally effective. The significantly higher wound complication rate in these patients makes the Linton procedure an obsolete one.

In *Chapter 6* the preoperative findings with reference to the number and localization of incompetent perforating veins on the medial side of the lower leg detected by duplex ultrasonography are compared to the findings at open surgical exploration (gold standard) in patients with venous ulceration of the lower limb. In a group of 20 patients 42 incompetent and 8 competent veins were detected on the medial side of the lower leg by duplex ultrasonography. During operation the location of all these 50 perforating veins appeared to be predicted correctly (specificity: 100%). Eleven additional perforating veins were found during operation, which were not visualized preoperatively by duplex ultrasonography (sensitivity: 79.2%). During duplex ultrasonography 6 weeks after operation, in none of the patients a persisting perforating vein was detected.
In patients with chronic venous insufficiency, it was concluded that duplex guided local exploration of the lower leg in search for incompetent perforating veins would miss a substantial number of these veins, possibly leading to incomplete healing or recurrent ulceration.

In *Chapter 7* the results are analyzed of the findings of duplex ultrasonography preoperatively and 6 weeks postoperatively in 20 patients with venous ulceration of the lower leg who underwent subfascial endoscopic perforating vein surgery (SEPS). In these 20 patients preoperative duplex ultrasonography showed 46 incompetent and 6 competent perforating veins. During operation the site of 43 incompetent and all competent perforating veins was confirmed. Five additional perforating veins were found at operation (false-negatives). Postoperative duplex ultrasonography showed 6 incompetent perforating veins (4 persisting and 2 recurring perforators) in 4 patients. In 3 of these 4 patients the ulcers did not heal while the ulcers of the other 17 patients all healed within 16 weeks.
It was concluded that SEPS by use of a mediastinoscope is an effective technique which permits identification of nearly all perforating veins. The persistence of incompetent perforating veins seems related to failure of ulcer healing.

The conclusion of this thesis is that venous ulceration of the lower limb is highly associated with the presence of incompetent perforating veins. These veins can be identified and interrupted endoscopically in the same surgical procedure in which concomitant superficial venous incompetence can be corrected. In our opinion venous ulceration of the lower leg is a surgical disease. Permanent healing may be anticipated in most of the patients when postoperative ambulant compression therapy is applied. In patients with chronic venous insufficiency the endoscopic approach of the subfascial space is preferable above open exploration because of similar healing rates and a significantly lower postoperative morbidity. For the detection of incompetent perforating veins duplex ultrasonography has a limited usefulness in patients with venous ulceration of the lower leg.

8.2 Samenvatting en conclusies

Het ulcus cruris venosum wordt beschouwd als het eindstadium van chronische veneuze insufficiëntie. Veneuze insufficiëntie leidend tot ulceratie kan gelegen zijn in het oppervlakkige veneuze systeem, het diepe veneuze systeem, het perforerende veneuze systeem of in combinaties hiervan. Uit epidemiologische onderzoekingen blijkt dat in de Westerse wereld deze chronisch recidiverende aandoening voorkomt bij 1-2% van de bevolking. Geschat wordt dat aan de behandeling van deze patiëntengroep jaarlijks in Nederland 1.8 miljard gulden besteed wordt. Conservatieve behandeling middels ambulante compressietherapie en het dragen van steunkousen geneest in de meeste gevallen het ulcus maar leidt in een hoog percentage tot recidief ulcerering.
Chirurgische behandeling gericht op het insufficiënte oppervlakkige en perforerende systeem leidt tot blijvende genezing in het merendeel van de patiënten maar gaat vaak gepaard met ernstige wondgenezingsstoornissen. In lijn met de hedendaagse interesse in minimaal invasieve chirurgische benaderingen wordt sinds 1985 getracht de insufficiënte venae perforantes subfasciaal te onderbinden langs endoscopische weg.

Hoofdstuk 1 beoogt een algemene inleiding te geven over deze endoscopische perforantectomie in het licht van anatomische, epidemiologische en sociaal-economische aspecten.

In *hoofdstuk 2* wordt een literatuuroverzicht gepresenteerd over de chirurgische behandelingsmogelijkheden van insufficiënte perforerende venen. De ontwikkeling van de subcutane, de subfasciale en tenslotte de endoscopische benadering wordt achtereenvolgens beschreven.

In *hoofdstuk 3* wordt de endoscopische subfasciale benadering en onderbreking van insufficiënte venae perforantes in het onderbeen met gebruikmaking van een mediastinoscoop en een lange cliptang in detail beschreven. Het belang van een goede kennis van de anatomie van het onderbeen, de aanwezigheid van het septum intermusculare medialis, het risico op het missen van insufficiënte perforerende venen en de aanwezigheid van een leercurve worden benadrukt.

In een retrospectieve studie worden de resultaten geanalyseerd van 38 patiënten met in totaal 40 benen met een recidiverend of persisterend ulcus cruris venosum die behandeld werden middels een subfasciale endoscopische perforantectomie met gebruikmaking van een mediastinoscoop. Eventueel aanwezige oppervlakkige veneuze insufficiëntie werd gecorrigeerd middels een korte stripping van de vena saphena magna. Zestien patiënten hadden op het moment van operatie een actief ulcus. Alle ulcera genazen binnen 2 maanden na operatie. Twee patiënten ontwikkelden postoperatief een wondcomplicatie. Na een gemiddelde follow-up duur van 3.9 jaar ontstond bij slechts 1 patiënt een recidief ulcus. Geconcludeerd wordt dat endoscopische perforantectomie een chirurgische techniek is met goede resultaten bij patiënten met chronische veneuze insufficiëntie gezien het hoge genezingspercentage, het lage recidiefpercentage en de kleine kans op postoperatieve complicaties. Deze bevindingen staan beschreven in *hoofdstuk 4*.

In *hoofdstuk 5* worden de resultaten beschreven van een prospectief, gerandomiseerd onderzoek dat de klassieke 'open' subfasciale perforantectomie (operatie volgens Linton) vergelijkt met de endoscopische benadering bij patiënten met een ulcus cruris venosum. Eventueel aanwezige geassocieerde oppervlakkige veneuze insufficiëntie werd tijdens dezelfde ingreep gecorrigeerd middels een korte stripping van de vena saphena magna. Alle patiënten werden nabehandeld middels ambulante compressietherapie. Tijdens een (vooraf niet geplande) interim-analyse bleek, nadat inmiddels 39 patiënten geïncludeerd waren, een groot statistisch significant verschil in de kans op het optreden van postoperatieve wondcomplicaties tussen beide groepen. Twintig patiënten werden endoscopisch

geëxploreerd waarbij geen enkele wondcomplicatie optrad in tegenstelling tot de groep van 19 patiënten die conventioneel geopereerd werden waar 10 wondcomplicaties werden vastgesteld ($p<0.001$). In beide groepen werden evenveel venae perforantes gevonden (gemiddeld: 3.0 (range: 1-6) respectievelijk gemiddeld: 2.9 (range: 1-6)). De gemiddelde opnameduur voor beide groepen bedroeg respectievelijk 7 (3-39) en 4 (2-6) dagen ($p = 0.001$).In beide groepen genazen 17 patiënten binnen 4 maanden na operatie. Na een gemiddelde follow-up duur van 21 maanden (spreiding: 16-29) werden bij deze 34 patiënten geen recidieven vast gesteld. Geconcludeerd wordt dat endoscopische benadering van insufficiënte venae perforantes bij patiënten met een ulcus cruris venosum de voorkeur verdient boven klassieke 'open' benadering. Het vergelijkbare genezingspercentage en de zeer lage postoperatieve morbiditeit maken de Linton operatie in deze patiëntenpopulatie obsoleet.

In *hoofdstuk 6* worden de gegevens met betrekking tot het aantal en de lokalisatie van insufficiënte venae perforantes aan de mediale zijde van het onderbeen, zoals preoperatief vastgesteld met Duplex onderzoek, vergeleken met de bevindingen tijdens 'open' subfasciale exploratie volgens Linton (gouden standaard) bij patiënten met veneuze ulceratie. In een groep van 20 patiënten werden met Duplex onderzoek 42 insufficiënte en 8 sufficiënte perforerende venen gevonden aan de mediale zijde van het onderbeen. Tijdens operatie kon de juiste lokalisatie van alle venen bevestigd worden (specificiteit: 100%). Elf venen werden peroperatief gevonden die preoperatief niet gezien waren (sensitiviteit: 79.2%). Postoperatief Duplex onderzoek, 6 weken na de operatie, liet geen enkele vena perforans meer zien.
Geconcludeerd wordt dat lokale, chirurgische benadering van venae perforantes op geleide van preoperatief Duplex onderzoek zal leiden tot het missen van een substantieel aantal venae perforantes, met daardoor een verhoogde kans op het niet genezen van het veneuze ulcus als gevolg.

In *hoofdstuk 7* worden de resultaten van Duplex onderzoek van de benen van 20 patiënten met veneuze ulceratie voor en 6 weken na endoscopische perforantectomie geanalyseerd. Bij deze 20 patiënten werden preoperatief 46 insufficiënte en 6 sufficiënte venae perforantes aangetoond. Peroperatief kon de lokalisatie van 43 insufficiënte en alle sufficiënte venen bevestigd worden. Tevens werden 5 vooraf niet ontdekte venen geïdentificeerd (vals-negatieven). Postoperatief Duplex onderzoek toonde 6 insufficiënte (4 persisterende en 2

recidiverende) venae perforantes bij 4 patiënten aan. Bij 3 van deze patiënten genas het ulcus niet. De ulcera van de overige 17 patiënten genazen alle binnen 16 weken. Geconcludeerd wordt dat subfasciale endoscopie met gebruikmaking van een mediastinoscoop een effectieve techniek is die vrijwel alle venae perforantes identificeert, en dat het missen van deze insufficiënte venae perforantes gerelateerd lijkt aan het persisteren van ulceratie.

Samenvattend kan geconcludeerd worden dat het ulcus cruris venosum bij het merendeel van de patiënten gerelateerd is aan het aanwezig zijn van insufficiënte venae perforantes. Deze venen kunnen endoscopisch geïdentificeerd en onderbroken worden tijdens een operatie waarbij eventueel tevens aanwezige oppervlakkige veneuze insufficiëntie eveneens gecorrigeerd kan worden. Het ulcus cruris venosum is in onze ogen dan ook een chirurgisch behandelbare afwijking. Wanneer deze patiënten nabehandeld worden met ambulante compressietherapie ontstaat in een hoog percentage blijvende genezing. Bij patiënten met chronische veneuze insufficiëntie is een endoscopische techniek te verkiezen boven de klassieke open benadering gezien hetzelfde succespercentage en de veel kleinere kans op wondcomplicaties. Voor het aantonen van insufficiënte venae perforantes heeft Duplex onderzoek bij patiënten met chronische veneuze insufficiëntie een beperkte waarde.

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CURRICULUM VITAE

Robert Pierik werd op 29 maart 1960 geboren in Terborg (Gld). Na het behalen van zijn Atheneum-B diploma in 1978 aan het St. Pauluslyceum te Tilburg vervulde hij vervroegd zijn militaire dienstplicht. In 1983 studeerde hij af als fysiotherapeut aan de Academie voor Fysiotherapie te Breda. In datzelfde jaar lootte hij, na vijf eerdere pogingen, in voor de studie Geneeskunde. In 1989 studeerde hij cum laude af als arts aan de Erasmus Universiteit te Rotterdam en ontving hierbij de studieprijs 1989 van Het Bataafsch Genootschap der Proefondervindelijke Wijsbegeerte.
Hierna volgde hij de opleiding tot algemeen chirurg; vanaf 1990 in het Academisch Ziekenhuis Rotterdam - Dijkzigt (opleider prof. dr H.A. Bruining) en vanaf 1992 in het Sint Franciscus Gasthuis te Rotterdam (opleider dr J.C.J. Wereldsma). Op 1 januari 1996 volgde registratie als algemeen chirurg, waarna hij het Fellowship Gastrointestinale en Laparoscopische Chirurgie vervulde in het Sint Antonius Ziekenhuis te Nieuwegein (opleiders dr T.J. Bast en dr P.M.N.Y.H. Go).
Per 1 april 1997 zal hij toetreden tot de maatschap Algemene Chirurgie van het ziekenhuis De Weezenlanden te Zwolle (in associatie met dr. M. Lopes Cardozo, dr. E.A. Kole, A.M. Blomme en L.A. Burghard).