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REVIEW ARTICLE

The Surgical Treatment of Incompetent Perforating Veins

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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.

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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, recording 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 recanalisation 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 recognised 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]

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Subcutaneous and Subfascial Approaches to the Perforating Veins

Robert Linton first recognised 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: removal of all enlarged superficial veins, subfascial ligation and division of all perforating veins of the lower leg, interruption of 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 of the treatment of venous ulcers has been the prevention of 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 extrafascial 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 counter the problem of wound healing 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 localisation 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 have 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 has also been described by others.[16, 36] Between 1961 and 1971 over 1000 patients were followed up after perforator 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 following 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 recognised.[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 specialised centres 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 postoperative wound problems were minimised, disadvantages included the blind fashion of this method and the frequent occurrence of painful subfascial haematoma formation as well as skin necrosis.[8] A combination of the Edwards introduction site and treatment under direct visual control led to the recent development of percutaneous, endoscopic techniques. The use of fibre-optics,[50] rigid endoscopic instumentarium[51] or a mediastinoscope[52, 53] allows subfascial ligation and sectioning of all perforating veins under direct vision and with minimal trauma. 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 varicose vein surgery in 94%. Postoperative delayed wound healing was observed in only 2.9%. Two patients (1.9%) complained of dysaesthesia in the area of distribution of the sural nerve. Other complications were: extended subcutaneous haematoma in 5.8% and postoperative dysaesthesia 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 mediastinioscope, 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 and is gaining ground as a surgical alternative in the treatment of venous ulceration 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 randomised 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% 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 in the field of venous ulcer disease have recently formulated a consensus paper containing valuable considerations for any clinical trial on the treatment of venous leg ulcers.[47] However, only very few prospective randomised 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 haemodynamics of incompetent calf perforating veins[27,63] a new period in the surgical treatment of venous ulceration may be expected.

References

1 Burnand KG. Aetiology of venous ulceration. *Br J Surg* 1990; **77**: 483–484.
2 Adams EF. *The Genuine Work of Hippocrates.* London: Sydenham Press. 1849.
3 Shami SK, Shields DA, Scurr JH, Coleridge Smith PD. Leg ulceration in venous disease. *Postgrad Med J* 1992; **68**: 779–785.
4 Dodd H, Cockett FB. *The Pathology and Surgery of the Veins of the Lower Limb.* Edinburgh, E & S Livingstone Ltd, 1956.
5 Bergan JJ. Historical highlights in teaching venous insufficiency. In: *Venous Disorders.* Editors: JJ Bergan and JST Yao. W. B. Saunders Company, 1991.
6 Madelung H. Uber die ausschalung cirsoider varicen an der unteren extremitaten. *Verhandl dentsch Gesellsch Chir* 1884; **13**: 114–117.
7 Babcock WW. A new operation for extirpation of varicose veins of the leg. *NY Med J* 1907; **86**: 153–156.
8 Negus D. *Leg Ulcers; a Practical Approach to Management.* Butterworth Heinemann Ltd, Oxford, 1991.
9 Gay J. On varicose disease of the lower extremities and its allied disorders. *Lettsomian Lectures of 1867*, London, Churchill, 1868.
10 Homans J. The operative treatment of varicose veins and ulcers based upon a classification of these lesions. *Surg Gyn Obstet* 1916; **22**: 143–158.
11 Homans J. The etiology and treatment of varicose ulcer of the leg. *Surg Gyn Obstet* 1917; **24**: 300–311.
12 Linton RR. The communicating veins of the lower leg and the operative technic for their ligation. *Ann Surg* 1938; **107**: 582–593.
13 Linton RR. The post-throbotic ulceration of the lower extremity: its etiology and surgical treatment. *Ann Surg* 1953; **138**: 415–430.
14 Cockett FB. The pathology and treatment of venous ulcers of the leg. *Br J Surg* 1956; **44**: 260–278.
15 Haeger K. Five-year results of radical surgery for superficial varices with or without coexistent perforator insufficiency. *Acta Chir Scand* 1966; **131**: 38–49.
16 Field P, Van Boxel P. The role of the Linton flap procedure in the management of stasis, dermatitis and ulceration in the lower limb. *Surgery* 1971; **70**: 920–926.
17 Puts JP, Gruwez JA. Surgical treatment of the post-thrombotic syndrome: improvement of the Linton operation by use of piracetam. *Br J Surg* 1993; **80** (Suppl): 115.
18 Dodd H. The diagnosis and ligation of incompetent perforating veins. *Ann R Coll Surg Engl* 1964; **34**: 186–196.
19 Healey RJ, Healey EH, Wong R, Schaberg FJ. Surgical management of the chronic venous ulcer: the Rob procedure. *Am J Surg* 1979; **137**: 556–559.
20 De Palma RG. Surgical therapy for venous stasis. *Surgery* 1974; **76**: 910–917.
21 Fegan WG. Continuous compression technique of injecting varicose veins. *Lancet* 1963; **ii**: 109–112.
22 Hobbs JT. The treatment of varicose veins: A random trial of injection compression therapy versus surgery. *Br J Surg* 1968; **55**: 777–780.
23 Henry MEF, Fegan WG, Pegum JM. Five-year survey of the treatment of varicose ulcers. *BMJ* 1971; **2**: 493–494.
24 Recek C. A critical appraisal of the role of ankle perforators for the genesis of venous ulcers in the lower leg. *J Cardiovasc Surg* 1971; **12**: 45–49.
25 Burnand KG, Lea Thomas M, O'Donnel TF, Browse NL. The relationship between postphlebitic changes in the deep veins and results of surgical treatment of venous ulcers. *Lancet* 1976; **i**: 936–938.
26 Akesson H, Brudin L, Cwikiel W, Ohlin P, Plate G. Does the correction of insufficient superficial and perforating veins improve venous function in patients with deep venous insufficiency? *Phlebology* 1990; **5**: 113–123.
27 Zukowski AJ, Nicolaides AN, Szendro G, Irvine A *et al.* Haemodynamic significance of incompetent calf perforating veins. *Br J Surg* 1991; **78**: 625–629.
28 Fischer R, Fullemann HJ, Alder W. A propos d'un dogme phlebologique sur les localisations des perforantes de Cockett. *Phlebologie* 1992; **45**: 207–212.
29 Editorial. Hidden perforating veins. *BMJ* 1970; **1**: 186.
30 Townsend J, Jones H, Edmund-Williams J. Detection of incompetent perforating veins by venography at operation. *BMJ* 1967; **3**: 583–585.
31 Beesley WH, Fegan WG. An investigation into the localization of incompetent perforating veins. *Br J Surg* 1970; **57**: 30–32.
32 Chilvers AS, Thomas MH. Method for the localization of incompetent ankle perforating veins. *BMJ* 1970; **2**: 577–579.
33 O'Donnell TF, Burnand KG, Clemenson G, Thomas ML, Browse NL. Doppler examination vs clinical and phlebographic detection of the location of incompetent perforating veins. *Arch Surg* 1977; **112**: 31–35.
34 Hanrahan LM, Kechejian GJ, Cordts PR, Rodriquez AA *et al.* Patterns of venous insufficiency in patients with varicose veins. *Arch Surg* 1991; **126**: 687–691.

35 NEGUS D, FRIEDGOOD A. The effective management of venous ulceration. *Br J Surg* 1983; **70**: 623–627.

36 WILKINSON GE, MACLAREN IF. Long term review of procedures for venous perforator insufficiency. *Surg Gyn Obstet* 1986; **163**: 117–120.

37 NEGUS D. Prevention and treatment of venous ulceration. *Ann R Coll Surg Engl* 1985; **67**: 144–148.

38 CIKRIT DF, NICHOLS K, SILVER D. Surgical management of refractory venous stasis ulceration. *J Vasc Surg* 1988; **7**: 473–478.

39 BRADBURY AW, RUCKLEY CV. Foot volumetry can predict recurrent ulceration after subfascial ligation of perforators and saphenous ligation. *J Vasc Surg* 1993; **18**: 789–795.

40 NASH TP. Venous ulceration: factors influencing recurrence after standard surgical procedures. *Med J Aust* 1991; **154**: 48–50.

41 BRADBURY AW, STONEBRIDGE PA, CALLAM MJ, RUCKLEY CV, ALLAN PL. Foot volumetry and duplex ultrasonography after saphenous and subfascial perforating vein ligation for recurrent venous ulceration. *Br J Surg* 1993; **80**: 845–848.

42 HOARE MC, NICOLAIDES AN, MILES CR, SHULL K, JURY RP, NEEDHAM T, DUDLEY HAF. The role of primary varicose veins in venous ulceration. *Surgery* 1982; **92**: 450–453.

43 SETHIA KK, DARKE SG. Long saphenous incompetence as a cause of venous ulceration. *Br J Surg* 1984; **71**: 754–755.

44 SHAMI SK, SARIN S, CHEATLE TR, SCURR JH, COLERIDGE SMITH PD. Venous ulcers and the superficial venous system. *J Vasc Surg* 1993; **17**: 487–490.

45 WILSON NM, RUTT DL, BROWSE NL. Repair and replacement of deep vein valves in the treatment of venous insufficiency. *Br J Surg* 1991; **78**: 388–394.

46 TAHERI SA, LAZAR L, ELIAS SM. Surgical treatment of post-phlebitic syndrome. *Br J Surg* 1982; **69**: 59–62.

47 The Alexander House Group. Consensus paper on venous leg ulcers. *Plebology* 1992; **7**: 48–58.

48 ALBANESE AR. Escoplage: a new surgical technique for the treatment of varicose veins in the legs. *J Cardiovasc Surg* 1965; **6**: 491–494.

49 EDWARDS JM. Shearing operation for incompetent perforating veins. *Br J Surg* 1976; **63**: 885–886.

50 FISCHER R. Surgical treatment of varicose veins; endoscopic treatment of incompetent Cockett veins. *Phlebologie* 1989; 1040–1041.

51 HAUER G. Die endoscopische subfasciale Diszision der Perforansvenen-vorlaufige Mitteilung. *VASA* 1985; **14**: 59.

52 WITTENS CHA, BOLLEN ECM, KOOL DR, VAN URK H, MUL T, VAN HOUTTE HJKP. Goede resultaten van subfasciale endoscopie als behandeling van insufficiente Vv. perforantes. *Ned Tijdschr Geneeskd* 1993; **137**: 1200–1204.

53 PIERIK EGJM, WITTENS CHA, VAN URK H. Subfascial endoscopic ligation in the treatment of incompetent perforating veins. *Eur J Vasc Endovasc Surg* 1995; 38–41.

54 JUGENHEIMER M, JUNGINGER TH. Endoscopic subfascial sectioning of incompetent perforating veins in treatment of primary varicosis. *World J Surg* 1992; **16**: 971–975.

55 FITZPATRICK JM, WICKHAM JEA. Minimally invasive surgery. *Br J Surg* 1990; **77**: 721–722.

56 KITSLAAR PJEHM, RUTGERS PH. Varicose veins and the vascular surgeon: from nuisance to challenge. *Eur J Vasc Surg* 1993; **7**: 109–112.

57 BOBEK K, CAJZL L, CAPELAK V, SLAISOVA V, OPATZNY K, BARCAL R. Etude de frequence des maladies phlebologiques et de l'influence de quelques facteurs etiologiques. *Phlebologie* 1966; **19**: 217–230.

58 BAKER SR, STACEY MC, JOPP-MCKAY AG, HOSKIN SE, THOMPSON PJ. Epidemiology of chronic venous ulcers. *Br J Surg* 1991; **78**: 864–867.

59 WIDMER LK. *Peripheral Venous Disorders.* Prevalence and socio-medical importance. Basel Study III. Bern: Hans Huber, 1978: 43–50.

60 CALLAM MJ, RUCKLEY CV, HARPER DR, DALE JJ. Chronic ulceration of the leg: extend of the problem and provision of care. *BMJ* 1985; **290**: 1855–1856.

61 CALLAM MJ, HARPER DR, DALE JJ, RUCKLEY CV. Chronic ulcer of the leg: clinical history. *BMJ* 1987; **294**: 1389–1391.

62 MAYBERRY JC, MONETA GL, TAYLOR LM, PORTER JM. Fifteen-year results of ambulatory compression therapy for chronic venous ulcers. *Surgery* 1991; **109**: 575–581.

63 SARIN S, SCURR JH, COLERIDGE SMITH PD. Medial calf perforators in venous disease: the significance of outward flow. *J Vasc Surg* 1992; **16**: 40–46.