Thieme

Possibilities to prevent recurrent varicose veins after surgery

Möglichkeiten zur Rezidivprophylaxe in der Varizenchirurgie

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ABSTRACT

The high rate of groin recurrences in varicose vein surgery has established a need for methods to prevent them. The use of different barrier techniques in the groin helps in reducing the reflux rate to 1.5 and 3 % within two to five years after the primary operation. Electrocoagulation of the stump endothelium with suturing of the lamina cribrosa and extensive crossectomy with stump oversuturing represent the most simple techniques. Even so, recurrence at the saphena femoral junction cannot be prevented in all cases. The remodelling hypothesis of varicose vein genesis, which includes chronic inflammatory processes, as well as further factors associated with recurrence seem to play a significant role in the pathophysiologic process. Therefore, in addition to barrier techniques conservative anti-inflammatory procedures should also be included in the therapy program: Vein-conscious lifestyle with compression-therapy, avoiding long sitting and standing, endurance sports and in case of obesity reduction of visceral fat tissue. Studies addressing this nonsurgical type of recurrence prevention are lacking.

ZUSAMMENFASSUNG

Die hohe Crossenrezidivquote in der Varizenchirurgie führt zur Verpflichtung, Maßnahmen zur Rezidivprophylaxe einzusetzen. Durch diverse Barrieretechniken an der Crosse lässt sich die Refluxquote auf Werte zwischen 1,5 und 3 % nach 2–5 Jahren bei einer Erstoperation reduzieren. Die einfachsten Techniken stellen die Elektrokoagulation des Crossenstumpfendothels mit Naht der Lamina cribrosa sowie die extensive Crossektomie mit Stumpfübernaht dar. Dennoch kann das Crossenrezidiv nicht völlig vermieden werden. Die Remodelling Hypothese zur Genese der Varikosis, welche mit chronisch inflammatorischen Prozessen einhergeht sowie die weiteren Faktoren, welche mit einem Crossenrezidiv assoziiert sind, spielen hier eine bedeutsame Rolle. Es sollten somit zusätzlich zu den Barrieretechniken auch nicht operative, antiinflammatorisch wirksame Maßnahmen in das Behandlungsspektrum aufgenommen werden: Venenbewusste Lebensführung mit Kompressionsstrümpfen, Vermeiden von langem Sitzen und Stehen, Ausdauerbewegungen und bei Übergewicht Reduzierung des viszeralen Fettgewebes. Studien zu dieser nicht operativen Form der Crossenrezidivprophylaxe fehlen jedoch.

Introduction

Recurrent varicose veins following surgical treatment present a huge problem to both patients and doctors. Operations on recurrences are more difficult, more time-consuming, and more expensive than primary interventions. Postoperative complications are more frequent than after primary interventions and may be serious [1–6].

In the literature, the frequency of recurrent saphenofemoral incompetence after surgery without any protection against neovascularisation is given as between 33 % [7] and 60 % [8]. For some time, therefore, efforts have been made to reduce the incidence of postoperative varicose vein recurrence.

Based on data in the literature and our own experience, this review will look at the current hypotheses on the development of vari-

cose veins, analyse the various types of recurrence, present the possibilities of preventing recurrences and define today's cutting-edge approach to high ligation of the saphenous vein. Given the phenomenon of neovascularisation (NV) and the remodelling hypothesis for the development of varicose veins associated with various inflammatory processes [9, 10] the question arises as to whether comprehensive prophylaxis against recurrent saphenofemoral incompetence is possible with surgical measures alone, or whether non-surgical measures have also to be included.

In addition, we will try to identify patient populations with a low or high risk of recurrent saphenofemoral incompetence and determine the patient group in which prevention of recurrence is not a main goal of varicose vein surgery.

For many years, it was thought that reflux through incompetent valves was pivotal in the development of varicose veins. More recently, however, there is evidence that valve dysfunction is not the actual cause of chronic venous insufficiency (CVI) and its progression, but rather remodelling of the vein wall with subsequent valve incompetence. Remodelling, triggered by physical flow characteristics and biochemical processes, is stimulated by unfavourable lifestyle factors such as sitting or standing for long periods, lack of exercise, and overweight [9, 10, 11, 12].

If remodelling of the vein wall is the crucial pathophysiological cause and valve incompetence is a secondary effect of this remodelling, the suspicion rapidly arises that surgical procedures on defective valves with stripping/exeresis of varicose veins cannot sustainably prevent recurrent saphenofemoral incompetence with any degree of certainty.

Classification of postoperative recurrence according to avoidability and site

Despite these limitations, for systematic didactic reasons we should first look at recurrence in terms of avoidability and unavoidability, as well as the site of recurrence in the groin and leg.

Avoidable recurrence:

This recurrence group is known to follow inadequacies in the diagnosis, determination of the indication, or surgical treatment. Such shortcomings include overlooking saphenofemoral incompetence during exclusive phlebectomy, incorrect high saphenous ligation, and leaving behind a duplicate main trunk vein or incompetent perforator.

Unavoidable recurrence:

If recurrent saphenofemoral incompetence or varicose veins in the leg appear – even many years later – after a high saphenous ligation that has been performed correctly, it has to be viewed as unavoidable. Apart from the remodelling process in the vein wall, recurrent saphenofemoral incompetence is also due to genetic factors [13, 14], other factors associated as shown in ▶ **Table 1**, and especially to neovascularisation.

Today, the existence of neovascularisation is generally accepted [1, 7, 8, 16, 17, 18, 19, 20, 21, 22], and various authors have tried to define it on the basis of macroscopic and histological criteria [17, 18, 19, 20, 22].

▶ **Table 1** Factors that are associated with neovascularisation and which secrete biochemical inflammatory and growth factors [9, 10, 15, 23, 24, 25].

Constellations that promote neovascularisation
• Extent of CVI
• Postoperative haematomas
• Adhesive tissue
• Previous pregnancy
• Postoperative pregnancy
• Obesity BMI > 29
• Small suprainguinal incision < 3 cm
• Total stripping to the medical malleolus
• Lack of exercise

▶ **Table 2** Molecular biology and platelet/endothelium interaction. All cell reactions are regulated by molecular biological processes or by platelet/endothelium interactions [7, 23, 24, 25, 26, 27].

Stimulation of neovascularisation by molecular biological processes
• VEGF (vascular endothelial growth factor)
• IGF (insulin light growth factor)
• NGF (nerve-growth factor) etc.
• Cytokines (more than 30)
• TGF (transforming growth factor)
• FGF (fibroblast growth factor)
• Prostaglandins
• Cyclo-oxygenase I and II

Endothelial hypoxia occurring in the stump left after saphenofemoral ligation seems to be of key importance in the pathogenesis of neovascularisation. It leads to activation of endothelial cells and increased release of inflammatory mediators. Molecular biological processes and a platelet/endothelium interaction are the key aspects [7, 23, 24, 25, 26, 27] (▶ **Table 2**).

A clear reason why neovascularisation occurs only in some patients has not yet been found. In short, we can only agree with Reinhard Fischer's summary of the phenomenon: No stump – no stump-related neovascularisation [25].

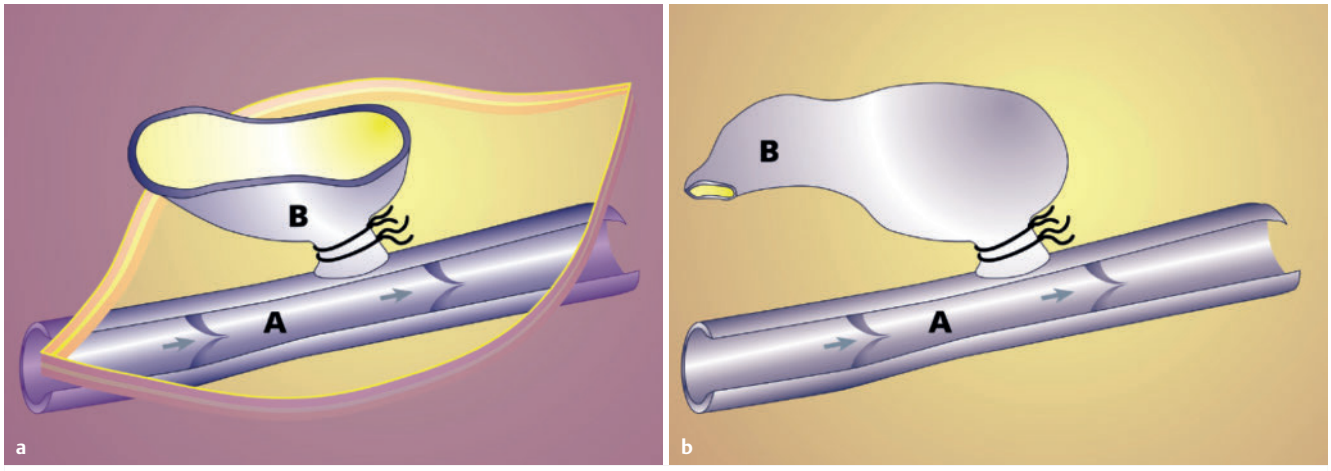
Recurrence prophylaxis

Avoidable recurrences

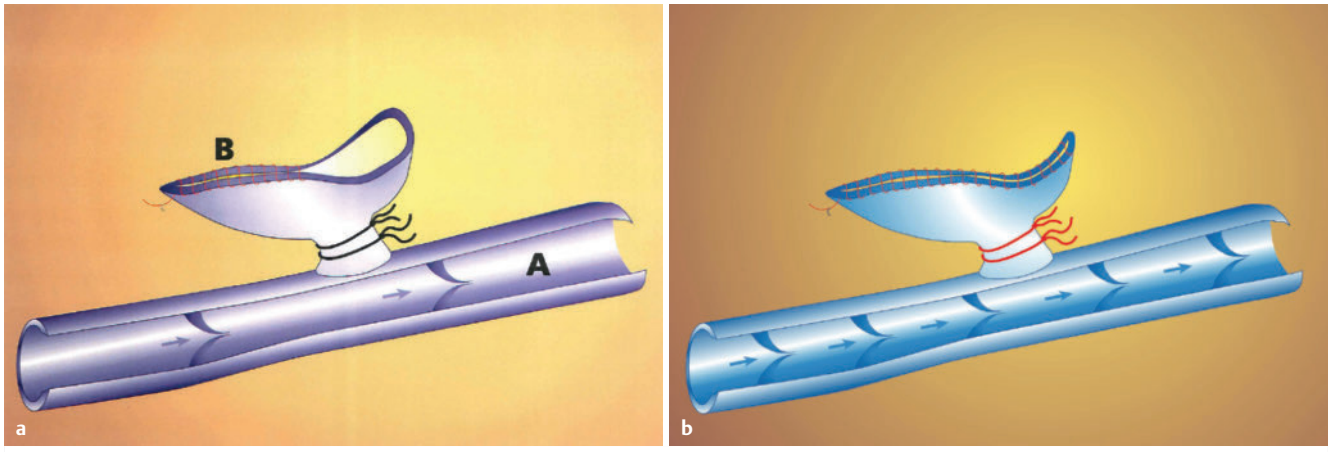
In comparison with other types, this group of recurrences is the easiest to prevent – at least in theory – by a well-trained vascular surgeon and the correct diagnostic investigation, indication for treatment, and surgical technique.

Saphenofemoral and saphenopopliteal junctions

Surgical errors at the saphenofemoral junction (SFJ) are a significant cause of recurrent varicose veins. There is a general agreement that ligation of the great saphenous vein flush with the femoral vein together with ligation of all the regional GSV tributaries together with



▶ **Fig. 1** Long SV stump (b) with adhesion of the free stump endothelium. A = femoral vein, B = SV stump [31]



▶ **Fig. 2** Continuous prolene overstitching of the SV stump, so that no free stump endothelium can come into contact with the surrounding tissues. A = femoral vein, B = SV stump [3]

ligation of the femoral vein tributaries can reduce the frequency of recurrent saphenofemoral incompetence [1, 3, 6, 20, 21, 25, 28].

Prophylaxis is disparately more difficult in the case of the small saphenous vein (SSV) ligation, possibly because of aneurysmal gastrocnemius veins that may grow in close proximity to the saphenopopliteal junction. Operating with the patient lying prone is the preferred position for preventing recurrence. Even so, the surgical procedure sometimes has to be limited and the possibility of junctional recurrence has to be accepted, in order to avoid any serious bleeding or nerve damage when dissecting out the tissues (Reinhard Fischer, personal communication).

Varicose veins of the leg

When all the relevant tributaries and incompetent perforators have been dealt with surgically or by occlusion, everything therapeutically possible has been done to prevent recurrence.

Unavoidable recurrence

Unfortunately, recurrence cannot be completely prevented even with the correct saphenous ligation or therapeutic technique.

Saphenofemoral junction

Neovascularisation is the most important pathogenetic factor for the surgeon with respect to recurrent saphenofemoral incompetence.

Apart from a precise high ligation, various surgical and barrier techniques able to reduce the rate of postoperative reflux have been published as prophylactic measures (▶ **Table 3**).

The definitive preventative approach consists of ensuring that widely gaping free endothelium is covered or eliminated following saphenous vein ligation:

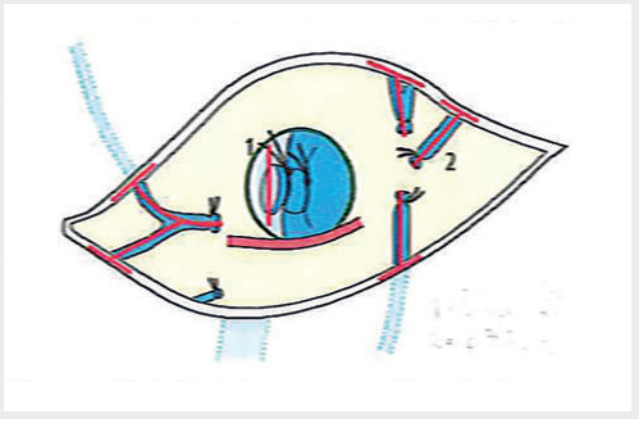
Long stump (▶ **Fig. 1**), overstitching of the junction (▶ **Fig. 2**), extensive high saphenous ligation and overstitching of the SV stump (▶ **Fig. 3**), electrocoagulation with lamina cribrosa suture (▶ **Fig. 4**), diverse patches (▶ **Fig. 5**) and stump excision (▶ **Fig. 6**).

The simplest surgical techniques are those which do not involve a patch or stump excision (▶ **Fig. 1** to ▶ **Fig. 6**).

These NV-prevention techniques used in primary interventions give results between 0 % (stump excision with a follow-up period of only three months) and 14 % (PTFE patch, follow-up 12 months). Taking only studies with follow-up periods of 2–5 years into con-

sideration, the recurrence rates lie between 1.5 % and 3 % [1, 3, 4, 16, 29, 30, 31, 32, 38] (▶ **Table 3**).

Even for surgery on recurrences, various barrier techniques can still be employed, including pectineal fascia occlusion, silicone patches, PTFE patches, and overstitching the stump with more extensive ligation. The postoperative recurrence rate in these cases lies between 2.4 % and 65 % [33, 34, 35, 36, 37] (▶ **Table 4**).



▶ **Fig. 3** Extensive saphenofemoral ligation with overstitching of the SV stump (1) as well as stripping of the tributary vessels (shown in red) well into the periphery (2) [4]

Varicose veins of the leg

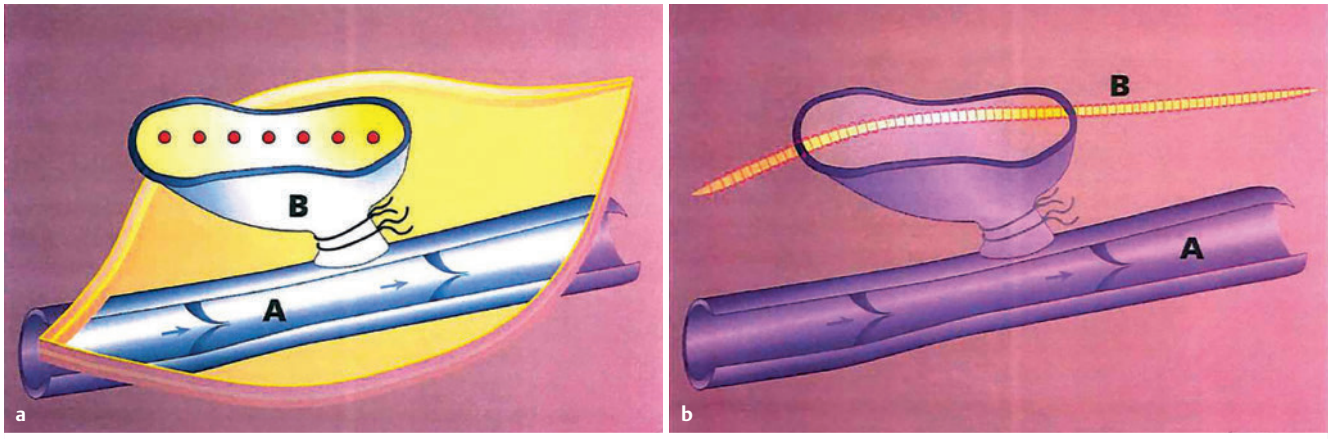
This type of recurrence, which – as mentioned above – is caused either by genetic factors or an unfavourable lifestyle (lack of exercise, overweight) with subsequent remodelling of the vein wall, is less easy to prevent than recurrence in the groin.

Indications for varicose vein surgery

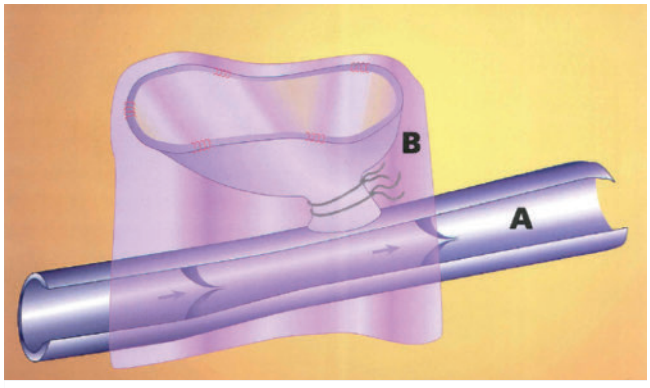
As recurrent saphenofemoral incompetence may unfortunately still occur even decades later, the intelligent indication for surgery in younger patients (possibly < 30 years) should err on the conservative side. If treatment is essential, endovascular techniques should be employed, allowing subsequent saphenous ligation to be carried out more easily than after primary high ligation.

Symptomatic indications

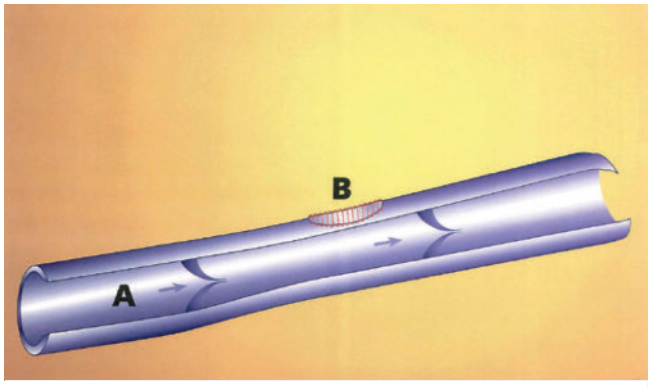
A curative indication with freedom from recurrence is not, however, the primary therapeutic goal for every patient. Elderly patients



▶ **Fig. 4** Electrocoagulation of the SV stump with lamina cribrosa suture (LaVaCro study). Left: A = femoral vein, B = SV stump. Right: A = femoral vein; B = suture of the lamina cribrosa [32]



▶ **Fig. 5** Covering the saphenous vein endothelium with various patches, aiming to prevent contact of the stump endothelium with the subcutaneous tissues. A = femoral vein, B = patch over the saphenous vein endothelium [1, 16, 29]



▶ **Fig. 6** Excision of the SV stump from the femoral vein with suture closure. With this technique there is no residual stump endothelium. A = femoral vein, B = closure of the femoral vein where the saphenous vein has been excised [30]

▶ **Table 3** Studies on neovascularisation prevention – primary surgical procedure [1, 3, 4, 16, 29, 30, 31, 32, 38].

Lead author	Technique	Legs (n)	Follow-up (months)	Recurrence
Glass 1998 [29]	Cribriform fascia, mersilene patch	127	>48	3.0 %
Jaeschock 1996 [30]	Stump excision	100	3	0 %
Earnshaw 1998 [1]	PTFE patch	51	12	14.0 %
De Maeseneer 2002 [16]	Silicone patch and cribriform fascia	210	12	6.0 %
Frings 2004 [31]	Long stump	65	9	5.0 %
Frings 2004 [3]	Endothelial suture	70	24	3.0 %
Frings 2010 [4]	Extended SFJ ligation	100	24	1.5 %
Papapostolou 2013 [32]	Electrocoagulation and cribriform fascia	668	12	2.2 %
Rass 2015 [38]	Extended SFJ ligation	129	60	1.6 %

▶ **Table 4** Studies on neovascularisation prevention – revision ('redo') surgery [33, 34, 35, 36, 37].

Lead author	Year	Technique	Legs (n)	Follow-up (months)	Recurrence
Gibbs [33]	1999	Pectineal fascia	34	>18	65 %
De Maeseneer [34]	2004	Silicone patch	34	60	9 %
Winterborn [35]	2007	PTFE	16	24	31 %
Freis [36]	2016	PTFE	85	12	2.4 %
Gerontopoulou (in press) [37]	2018	Overstitching, extended redo FJ ligation	100	16	5 %

with very painful varicose veins, recurrent phlebitis or bleeding from ruptured varicose veins and people with medical risk factors should have their varicose veins eliminated quickly, safely and without risk – always remembering that minimally invasive techniques are not worthwhile. This population also includes obese patients with painful lipolymphoedema who are planning to have joint replacement for painful osteoarthritis of the hip or knee. With this particular constellation, recommendations for gait training and weight reduction are not constructive. Here, too, primary treatment consists of reliable, safe elimination of the varicose veins so that orthopaedic surgery can be performed. Physical measures of drainage, gait training, and weight reduction can only be introduced once the joint pain has been reduced. Any possible later groin or leg vein recurrence requiring treatment can then be dealt with by open surgery or minimally invasive techniques under much more favourable circumstances.

Identifying patients at low or high risk of recurrent saphenofemoral incompetence

In our experience, slender or moderately overweight patients with little adhesive tissue found in the groin at operation – that is to say, those who have not had any previous inflammatory processes in the leg, catheter investigations, extensive prior treatment with sclerotherapy or phlebectomy, or any tattoos affecting the inguinal lymph nodes – have the lowest risk of recurrent saphenofemoral incompetence. After surgery, the patients themselves can reinforce this low risk by introducing or continuing to follow a lifestyle that is beneficial to the veins. This includes maintaining a normal weight or being only moderately overweight, avoiding standing or sitting for long periods, possibly wearing compression stockings if their work involves strain on the legs, and taking regular endurance exercise.

If surgical repair of the SFJ valve is carried out with an extraluminal valvuloplasty where the SV stump is not divided, endothelium-induced neovascularisation cannot by definition occur.

Discussion

The sobering results of varicose vein surgery without recurrence prophylaxis place an obligation on the surgeon to implement barrier techniques into the spectrum of treatment. As surgical measures alone cannot achieve freedom from groin recurrence over many years, due to neovascularisation and remodelling of the vein wall in association with various biochemical and inflammatory processes, non-surgical measures should also be incorporated into the therapeutic options.

Remodelling with progression of the varicose veins cannot be stopped or reversed with complete regression of the changes in the vein walls (reverse remodelling). On the contrary, pathogenic biochemical changes take place not only in the obvious varicose veins but also in segments of vein in which no macroscopic wall changes can be seen. These veins are 'potentially varicose' [9].

Nevertheless, we consider a correct high saphenous ligation to be merely the minimum treatment programme for recurrence prophylaxis. Cutting-edge medicine today demands the inclusion of a barrier technique: endothelial coagulation of the SV stump with lamina cribrosa suture [32] and extended SFJ ligation with overstitching of the stump [4] represent the most straightforward of these techniques. Unfortunately, even such refined procedures cannot completely prevent recurrent saphenofemoral incompetence in the long term. The best results show 1.5 % to 3 % groin recurrence after 2–5 years under study conditions, while the rates of reflux found in routine clinical practice are certainly higher. Unfortunately, there are no reliable ultrasound-controlled studies over a period of much more than 10 years. Rass has found evidence that local tumescence anaesthesia also has a protective effect against neovascularisation [38].

Optimal recurrence prophylaxis therefore does not have to involve surgical procedures. The most important approach is to persuade the patient to introduce and maintain changes in lifestyle that have an anti-inflammatory effect, such as weight reduction and intensive endurance exercise.

Although the varicose veins and valve incompetence basically have to be viewed as irreversible changes, they can be partially compensated by compression therapy and active use of the muscle and joint pump. Increasing venous tone with medication may also help [9]. We can assume that meaningful measures in patients with lipoedema, such as an anti-inflammatory low carbohydrate (ketogenic) diet and reduction of visceral fat with diminished production of numerous hormones and neovascularisation-promoting cytokines are also worth recommending for the prevention of recurrent varicose veins (an in-depth discussion can be found elsewhere [39]). Complications of any recurrent varicose veins can be minimised if the patient attends regularly for follow-up: the recurrence can be dealt with at an early stage with sclerotherapy or another minimally invasive technique.

Ideally, patients should be informed about non-surgical preventative measures before they undergo surgery.

Most patients are then highly motivated and ask about what they can do themselves. In the preoperative briefing sessions, key aspects include emphasising the importance of a lifestyle beneficial to the veins and paying attention to the weight factor. Additionally, an anti-inflammatory diet can be suggested to obese patients with lipoedema [39]. As it is well known that health education alone has little effect, it is advantageous to let patients develop a positive relationship to their bodies and legs through endurance training. This approach is hardly possible in an outpatient or day-care varicose vein surgery setting, but patients who have been admitted to hospital for longer periods can participate in power walking and vein exercises in group sessions. In many cases, patients do actually follow our recommendation to continue this programme after discharge as their motivation is high.

There are no prospective studies on the efficacy of these theoretically meaningful non-surgical prophylactic measures and, indeed, such studies would be difficult to carry out, as they would require long-term follow-up. We can only hope that comprehensive recurrence prophylaxis will reduce the healthcare costs, but we cannot make any firm predictions at the present time.

At least theoretical future therapeutic approaches include the use of neovascularisation-inhibiting substances such as aspirin, and even eliminating the genetic factors responsible for recurrence [40, 41].

CONCLUSIONS

Correctly performed high ligation is the minimum requirement for the prevention of saphenofemoral recurrence. Cutting-edge medicine today demands the additional use of a barrier technique. Optimal recurrence prophylaxis can, however, only be achieved by the addition of non-surgical anti-inflammatory measures. Factors that are associated with recurrent saphenofemoral incompetence – in particular lack of exercise and abdominal obesity – have to be mentioned here. Taking the remodelling hypothesis into account, analysis of data from the literature supports this approach to treatment even though no prospective studies are available.

Conflict of interest

The authors declare that they have no conflicts of interest.

References

[1] Earnshaw JJ, Dqavies B, Harradine K et al. Preliminary results of PTFE patch saphenoplasty to prevent neovascularisation leading to recurrent varicose veins. Phlebology 1998; 13: 10–13

[2] Frings AC. Der Einfluss der extensiven Crossektomie der Vena saphena magna auf die Neorefluxrate in der sapheno-femoralen Junktion [Dissertation] Nordrhein-Westfalen, Bochum: Ruhr-Universität Bochum; 2016

[3] Frings N, Nelle A, Tran Ph et al. Reduction of neoreflux after correctly performed ligation of the saphenofemoral junction. A randomized trial. Eur J Vasc Endovasc Surg 2004; 28: 246–252

[4] Frings N, Frings AC, Tran P, Schubert R. Reduzierung des Neorefluxes an der V. saphena magna Crosse durch extensive Crossektomie. Phlebologie 2010; 40: 325–328

[5] Loeprecht H. Varikose – chirurgische Therapie. Der Chirurg 1997; 68: 1048–52

[6] Perrin MR, Guex JJ, Ruckley CV et al. Recurrent varices after surgery (REVAS), a consensus document. Cardiovasc Surg 2000; 8: 233–245

[7] Frings N, Tran P, Nelle A et al. Crossenrezidiv der V. saphena magna trotz korrekter Crossektomie: Neoangiogenese. Phlebologie 1999; 28: 144–148

[8] Fischer R, Linde N, Duff C et al. Late recurrent saphenofemoral junction reflux after ligation and stripping of the greater saphenous vein. J Vasc Surg 2001; 34: 236–240

[9] Buddecke E. Pathobiochemie des Venenwand in: Marshall M. Breu FX. Handbuch der Angiologie –Arterien-, Venen- und Lymphgefäßerkrankungen in Klinik und Praxis. Landsberg: ecomed, 2007: 1–10

[10] Pfisterer L, König G, Hecker M et al. Pathogenesis of varicose veins – lessons form biochemics. Vasa 2014; 43: 88–99

[11] Göstl K, Obermayer A, Hirschl M. Pathogenesis of chronic venous insufficiency by obesity. Phlebologie 2009; 38: 108–113

[12] Vlajinac HD, Marinkovic JM, Maksimovic MZ et al. Body mass index and primary chronic venous disease – A Cross-sectional study. EJVS 2012; 45: 293–298

[13] Ellinghaus E, Ellinghaus D, Krusche P et al. Genome-wide association analysis for chronic venous disease identifies EFEMP1 and KCNH8 as susceptibility loci. Sci. Rep.7, 45652; doi: 10.1038/srep45652 (2017)

[14] Fiebig A, Krusche P, Wolf A et al. Heritability of chronic venous disease. Springer; 2010: Doi. 10.1007/s00439–010–0812–9

[15] Fischer R, Chandler JG, Stenger D et al. Patient characteristics and physician-determined variables affecting saphenofemoral reflux recurrence after ligation and stripping of the great saphenous vein. J Vasc Surg 2006; 48: 81–87

[16] De Maeseneer MG, Giuliani DR, Van Schil PE et al. Can interposition of a silicone implant after sapheno-femoral ligation prevent recurrent varicose veins ? Eur J Vasc Endovasc Surg 2002; 24: 445–449

[17] Glass GM. Neovascularization in recurrence of the varicose great saphenous vein following transaction. Phlebology 1987; 2: 81–91

[18] Glass GM. Neovascularization in recurrence for varices of the great saphenous vein in the groin: Phlebography. Angiology 1988; 39: 577–582

[19] Mumme A, Olbrich S, Barbara L et al. Validität der makroskopischen Identifikation von Neovaskulaten durch den Operateur. Phlebologie 2003; 32: 143–146

[20] Frings N, Nelle A, Tran VTP et al. Unavoidable recurrence and neoreflux after correctly performed ligation of the saphenofemoral junction: neovascularisation? Phlebologie 2003; 32: 96–100

[21] Mumme A, Olbrich S, Babera L et al. Sapheno-femorales Leistenrezidiv nach Stripping der Vena saphena magna: technischer Fehler oder Neovaskularisation. Phlebologie 2002; 31: 38–41

[22] De Maeseneer M, Vandenbroeck C, Hendriks J et al. Accuracy of duplex evaluation one year after varicose vein surgery to predict recurrence at the sapheno-femoral junction after five years. Eur J Vasc Endovasc Surg 2005; 29: 308–312

[23] Fischer R, Kluess G, Frings N et al. Der aktuelle Stand der Magnacrossenrezidiv-Forschung. Phlebologie 2003; 32: 54–59

[24] Rewerk S, Noppeney T, Winkler M et al. Pathogenese der Primär- und Rezidivvarikosis an der Magna-Crosse. Phlebologie. 2007; 36: 137–142

[25] Fischer R, Chandler JG, De Maeseneer M et al. The unresolved problem of recurrent saphenofemoral reflux. Am Coll Surg 2002; 195: 80–94

[26] Pinedo HM, Verheul W, Amato RJD et al. Involvement of platelets in tumour angiologies? Lancet 1998; 352: 1775–1777

[27] Kujath P, Michelsen A. Wunden – von der Physiologie zum Verband. Dtsch Ärztebl 2008; 105: 239–248

[28] Mumme A, Hummel T, Burger P et al. Die Crossektomie ist erforderlich! Ergebnisse der Deutschen Leistenrezidivstudie. Phlebologie 2009; 38: 99–102

[29] Glass GM. Prevention of sapheno-femoral and sapheno-popliteal recurrence of varicose veins by forming a partition to contain neovascularization. Phlebology 1998; 13: 3–9

[30] Jaeschok RR, Bahrami F. The safe ligation of the spahenofemoral junction – a technical alternative. Procedings of the German Association for Phlebology, Berlin 1996; abstract 38

[31] Frings N, Tran P, Nelle A et al. Freies Endothel des Magna-Crossenstumpfes und Neoreflux/ Neoangiogenese. Phlebologie 2004; 33: 156–159

[32] Papapostolou G, Altenkämper H, Bernheim C et al. The LaVaCro study: long-term results after saphenofemoral ligtion and stripping of the great saphenous vein. Phlebologie 2013; 42: 253–260

[33] Gibbs PJ, Foy DMA, Darke SG. Reoperation for recurrent saphenofemoral incompetence: a prospective randomized trial using a reflected flap of pectineus fascia. Eur J Vasc Endovasc Surg 1999; 18: 494–498

[34] De Maeseneer MG, Vandenbroeck CP, Van Schil PE. Silicone patch saphenoplasty to prevent repeat recurrence after surgery to treat recurrent saphenofemoral incompetence: Long-term follow-up study. J Vasc Surg 2004; 40: 98–105

[35] Winterborn RJ, Earnshaw JJ. Randomized trial of polytetrafluorethylene patch insertion for recurrent great saphenous varicose veins. Eur J Vasc Endovasc Surg 2007; 34: 367–373

[36] Freis H, Geier B, Mumme A et al. Barrier patch im plantation during redo surgery for varicose vein recurrences in the groin: 1-year results. Ann Vasc Surg 2016

[37] Gerontopoulou SA, Kath W, Rass K. Short-term efficacy of inguinal reoperation for recurrent saphenofemoral incompetence using the stump suture technique. [in press]

[38] Rass K, Frings N, Glowacki P, Gräber S, Tilgen W, Vogt T. Same site recurrence is more frequent after endovenous laser ablation compared with high ligation and stripping of the great saphenous vein: 5 year results of a randomized clinical trial (RELACS study). Eur J Vasc. Endovasc Surg 2015; 50: 648–656

[39] Faerber G. Adipositas und chronische Inflammation bei phlebologischen und lymphologischen Erkankungen. Phlebologie 2018; 47: 55–65

[40] Frings N. Update zur Neoangiogeneseforschung an der Magna-Crosse 53. Jahrestagung der Deutschen Gesellschaft für Phlebologie: Berlin 2011; Vortrag

[41] Frings N. Pharmakologische Hemmung der Neoangiogenese (NeoA) an der Magna-Crosse durch Acetylsalicylsäure – eine Pilotstudie. 53. Jahrestagung der Deutschen Gesellschaft für Phlebologie: Berlin 2011; Vortrag