INTRODUCTION

When one reads authors from the start of the century, one learns that all the methods of stripping used today were invented and developed during that period. Stripping by invagination, as described by Keller in 1905 [1], was immediately adopted and was much discussed by those who were already using catheter invagination, and who very clearly described how to unhook the collaterals in the thigh in order to avoid rupturing the saphenous vein [2]. In 1906, Mayo [3] described a stripping technique that involved pushing, around the vein, a ring fixed to a rod, and in 1907 Babcock [4] described stripping as we know it today. Since then all sorts of oliva and stripping methods have been invented, but the principles of saphenous exeresis remain the same. There are 4: saphenectomy with ring stripping (Mayo) [3], invaginated stripping by Keller [1], stripping by exoluminal telescoping (Babcock) [4] where the îgatheringî oliva is designed, through its cupule shape, its size and its rigidity to go beyond the diameter of the stripped saphenous vein, and stripping by intraluminal telescoping where the oliva remains strictly within the saphenous lumen and is used to telescope the saphenous vein like an accordion onto the stripper.

OPERATING TECHNIQUES

For the description of long saphenous stripping, we must remember that this technique was designed for use under local and/or regional anaesthesia and ambulatory treatment. This means, without departing from the precise requirements for exeresis imposed by preoperative mapping, the operation must be as painless and as safe as possible. Stripping is carried out with the limb flat, the knee bent, the hip in abduction, after shaving the pubis, and without covering the toes.

Crossectomy

- The crossectomy incision is made above the fold, fairly obliquely, high up within the pubic triangle. Taking into account the prevalent orientation of the pubic hairs, the cutaneous incision must be made slightly obliquely and back, down and outside. An incision of between 3 and 4 cm, with Farabeuf retractors (15 mm by 35 mm blades) are generally sufficient to carry out a good crossectomy. Despite the inconvenience of a greater thickness of subcutaneous fat, and the fact that it is located in a hairy zone, an pubic incision further away is more aesthetic, and is less painful after the operation, being in an area which is less prone to movement. For obese patients, a horizontal incision in the inguinal fold may make the operation easier if the saphenous junction is low, but despite the thickness of the subcutaneous tissue it is often simpler to make an incision well above the fold and the inguinopubic fold on an area of flat skin. Two large Farabeuf retractors (25-30 mm by 60 mm) are always sufficient.
- The crossectomy is carried out in a systematic manner. The dissection is made along the saphenous vein, progressively, up to the femoral vein. The saphenous vein is
immediately attached as close as possible to the first branches with Vicryl thread, and, after section, the distal part is left in forceps under the internal inferior Farabeuf. This procedure often allows one to untwine the saphenous vein of the pudendal artery which passes in front of the saphenous vein in 35% of cases [5]. It is important not to bind it, firstly in order to avoid taking any risk of postoperative bleeding, but above all to avoid the risk of sexual impotency for men. Several cases of sexual impotency after crossectomy have been reported, and have been put down to ligation of the pudendal artery. The latter, in certain atheromatous patients or in patients with anatomical anomalies in the pudendal artery, can take over the vascularization of the penial arteries or those of the clitoris. Examination of the dorsal penial arteries of the penis with a velocimeter, then shows that flow is stopped during manual compression of the common femoral artery [6,7]. Rather than ligating the collaterals right at the junction, one gradually places Vicryl ligations on the saphenofemoral junction just below each branch or group of branches. Clips are placed laterally, as far away as possible, separately beyond each dividing branch. Sections are always done after the ligations, and no forceps are left in place, which makes operative exhibition easier [8,9]. A second vicryl ligation is simply done tight against the femoral artery beyond the first knot which is held and maintained by the threader. After the crossectomy has provided a clear view, exploration of the lateral faces of the femoral veins should be complete. There is often a pudendal vein that needs to be ligated; it is important to incise the Allan Burns ligament in order to control the front side of the femoral vein, to the search for subfascial collaterals of the saphenofemoral junction [10]. Sometimes there is a collateral which runs very close to the femoral and which, because it runs alongside the adventitia, may be confused with an adventitial fold during traction on the stump.

• Certain methods have been suggested to help reduce the risk of recidivation. The microcoagulation of the venous endothelium of the stump of the saphenofemoral junction and the burying of the stump with a continuous suture of prolene allow one to avoid the residual venous wall coming into contact with the sub-cutaneous tissues. Complete re-section of the stump and of the transverse suture of the femoral vein is an ideal gesture, but its advantage has not yet been demonstrated. More simply, Glass [11] has shown that closing the pre-vascular fascia in front of the stump is just as efficient in the prevention of angiogenesis as placing prosthetic material between the stump and the sub-cutaneous tissue [12-15]. The incision is closed without drainage, simply using an intradermal continuous suture of vinyl with rapid resorption.

Passage of the stripper

Stripping first of all requires that a stripper be passed into the saphenous vein. With regard to long stripping, if the stripper is inserted upwards, there is a risk that it may unintentionally be inserted into the deep tract; on the other hand, when the stripper is inserted downwards, there is a theoretical risk of the head of the stripper entering a saphenous collateral [16]. It is generally considered easier to insert the stripper upwards towards the valves than downwards from the groin to the inside foot. Indeed, during 1,300 upward strippings between 1992 and 1993 (see Table 2), 27% of cases saw the stripper getting caught, thus obliging us to insert a second stripper downwards in order to free the first; wrong passages requiring an additional incision represented approximately 22% of upward strippings. Without giving any details of the direction of the stripping, Jacobsen [17] provides identical statistics (82% based on 200 cases) for direct
passage of the stripper without need for any additional incision. Although some people [18] prefer flexible strippers, we believe that the straight and rigid stripper is far more efficient [19]. Furthermore, when saphenous perforation takes place close to a previous incision, it is then advantageous to be able to move the stripper through the sub-cutaneous tissue, sometimes over a distance of 30 or so centimetres, in order to bring it out through the incision that has already been made. We use the Vastrip 2+ stripper (Astra-Tech, M’Indal, Sweden) which has the advantage of being symmetrical, straight and rigid. During the descent of the stripper, certain manoeuvres can aid valve progression in the opposite direction; synchronous compression of the upward saphena can sometimes, by opening the valves, help the stripper to push downwards; lateral pinching of the vein at the end of the stripper sometimes aids passage, maybe by opening valves by bringing together the commissura located on the two free sides of the saphenous vein [20,21]. In a more recent study (Table 1), which this time concerns the downward progression of the stripper, out of 191 cases we can see a higher percentage of strippers getting caught (44%), but a lesser number of false passages requiring an additional incision (15%). A comparison of the 2 methods of inserting a stripper (upwards or downwards) in long stripping, shows a clearly greater efficiency for the downward technique. This somewhat curious observation, along with increased indications with regard to short stripping, makes us believe that downward stripping should always be used. The lower approach to the saphenous vein is always made on the inside of the foot, with a transverse incision of approximately 7 mm. Out of 80 short stripplings under the knee, Corbett [22] has shown a 91% rate for passage, identical for both metal and disposable strippers, but with faster passage for disposable strippers. Plastic disposable strippers have a remarkable resistance to traction: up to 33 kg for the Vastrip, and up to 40 kg for the Codman stripper [23].

**Invaginated stripping**

Unlike Van der Stricht's [24,25,26] initial description, we prefer invagination by traction on an unstretchable element which allows one to better judge the elastic stretching of the saphenous vein or of its branches, thus limiting the risk of rupture. We always use invagination on the stripper [27]. Ligation of the saphenous vein onto the stripper is simply effected using two bows of unstretchable nylon, decimal 6 and 2.5 meters long (Péternyl, Peters, Bobigny, France). The thread remains in the saphenous tunnel until the end of the operation; it is used as a guide should there be any rupture of the saphenous vein. Before beginning the stripping, which we always perform downwards in order to avoid putting the saphenous collaterals under any direct tension via axial traction, we section, for preventive reasons, the first posterointernal collaterals of the saphenous vein by bending the thigh as far as possible and by pulling the distal end of the thigh saphenous vein. It is often very easy to tie the first collaterals in order to avoid hematoma in the upper part of the thigh which is difficult to compress using postoperative dressing. The progression of the stripping is downwards, sectioning the collaterals with the bevelled cutting edge of an intramuscular needle or with a Muller's hook [28,29] (Automatisme Robotique Pitot Padulli, Lézoux, France). When the saphenous vein ruptures, the nylon thread is simply fixed by two knots around the distal end of the saphenous vein on the inside part of the foot, and invagination continues upwards. If a new
rupture takes place above the previous one, the section of remaining saphenous vein, located by putting the thread under tension, is extracted by phlebectomy or by intraluminal telescopic stripping with a soft oliva. This soft oliva is carried out with a fragment of the long saphenous vein that has already been stripped, tied to the traction thread. We felt that passing a soft bendable oliva into the tissues was less aggressive than the rigid oliva which is normally used for exoluminal telescopic stripping. Out of a total of 1,500 invaginated stripplings carried out between 1988 and 1992 [30] (Table II), 70% were complete invaginated stripplings with or without intermediary rupture, and 28% were incomplete with two ruptures that required this artifice to be used for ablation of a part of the residual saphenous vein. This portion of the saphenous vein represents approximately a quarter of its overall length; with regard to this portion, in 2% of cases, we were obliged to use a traditional rigid oliva. In such cases, when one re-inserts the stripper into the saphenoctomy tunnel and into the residual portion of the saphenous vein, one needs a stripper that can have a thread attached to its end. Certain metal strippers allow this: the Fischer stripper [31,32] (Salzmann, St. Gallen, Switzerland) has a small foam head which screws onto its end, with a slot that allows one to attach a thread before putting the stripper back into the tunnel, and the portion of the residual saphenous vein without harming the tissues. The Hardilier stripper has an orifice at one end, to which one can attach a traction thread. When the nylon thread has remained inside the portion of residual saphenous vein, it is possible, without using a stripper, to directly attach the free head of a Vastrip-type stripper onto the nylon thread in order to perform a downward exoluminal telescopic stripping of the portion of residual saphenous vein. In order to avoid rupturing the saphenous vein during invagination, some authors [33] recommend pulling a pack of gauze behind the head of the stripper. When this pack is inserted into the invaginated saphenous vein, it divides traction and limits the risk of rupture: (Ouvry [33] reports rupture in 147 cases, but with partial telescoping in 40 cases). Despite this inconvenience, invagination remains the ideal technique for saphenous exeresis [34, 35]. We were able to verify the somewhat aggressive side of invagination in the mixed saphenous exeresis that we performed, by invagination and by exoluminal telescoping, on two segments of the same saphenous vein (Figure 1).

**Stripping by exoluminal telescoping**

The huge advantages of exoluminal telescopic stripping are its simplicity, rapidity and efficacy. This type of stripping was first described by Babcock [4, 35], and is now very widely used. Traditionally speaking, downward stripping is supposed to achieve a fuller and longer ablation of the collateral branches; but the comparative study carried out by Jacobsen [36] did not confirm this theory. Many people have adapted this type of stripping in order to reduce the aggressive aspect. Thus, after performing a downward stripping, one can extract the saphenous vein along the stripper via a small low incision without pulling out the head of the stripper: the latter is pulled back up by the thread and extracted through the crossectomy incision [37, 38]. This procedure means being able to bring the head of the stripper back up without it becoming caught in the saphenectomy tunnel [41]. The head of the Vastrip stripper can be easily perforated with an 11 blade in order to attach a traction thread.

**Stripping by intraluminal telescoping**

Intraluminal telescopic stripping is an intermediate solution that combines efficacy with less aggression. It was initially developed by Degni [42]; the head of the stripper is biconical and
grooved, and is inserted into the corner of the saphenous lumen. The venous wall, gathered like an accordion in front of the head of the stripper, opens the tissues in a less aggressive manner during the stripping process. In our experiment we performed this intraluminal telescopic stripping in two ways (Figure 2). First of all, using a knob of tamponade soaked in Lidocaine to soften the surrounds, the tamponade being fixed onto the saphenous vein at the head of the stripper (146 cases) and with a piece of Mérocel (Xomed-France, Les Ulis, France) soaked in Lidocaine attached to the vein (430 cases). We feel that the big advantage with Mérocel is that it forms a perfectly soft oliva, bendable and flexible, and which moulds itself inside the saphenous lumen during telescoping, thus minimising the trauma of stripping. The Mérocel sponge is also extremely solid (it only tore once out of the 430 downward strippings). It is difficult to choose the size of the soft oliva for intraluminal telescopic stripping, because if it is too small, the telescoped saphenous vein ends up being invaginated in the trunk, and then splits from end to end; if it is too big, the telescoped volume causes major unsticking.

Short stripping

Partial stripping is necessary in 30% of cases, if we take the preoperative hemodynamic report into account, and if we respect the principles of conservative surgery [43, 44]. Short stripping may be performed by invagination on thread or on a mini-stripper (Goren) [45, 46, 47]. Short stripping from the groin to the area where reflux stops, or partial saphenous stripping up to the upper part of the leg is performed with an Oesch pin-stripper [46, 48, 49] (Tischer, Bern, Switzerland); its rigidity means that it is easy to guide; after perforating the end of the saphena, it is extracted via a small phlebectomy incision. The unstretchable nylon thread is passed through the hole at the end of the pin-stripper and simply tied to the saphenous vein by two knots 1 cm from the end (Figure 3). This method has always allowed us to perform invagination under good conditions. The advantage of the pin-stripper is that it is easy to use in very short strippings (30 or so cms), for the short saphenous vein with a perfectly aesthetic distal incision. Its size, 52 cms, means that it can very often be used down to mid-leg level.

Stripping of the short saphenous vein

Short saphenous vein stripping should, ideally, be performed under local anaesthesia in a prone position, with the knee slightly bent. The incision is horizontal, between 3 and 5 cms long, centred 2 cms below the sapheno-popliteal junction, previously located with a Doppler ultrasonic scan with the patient standing. The aponeurosis is cut crossways and, after section of the short saphenous vein, dissection is carried out as close as possible to the short saphenous vein, from the surface downwards. With binocular loupes, two long narrow retractors (3cm x 1cm) are generally sufficient. Section of the stump, under traction, of the short saphenous vein is
performed after two vicryl ligations level with the deep vein or with the short saphenous junction - trunk of gastrocnemius veins if continent. Despite the great variety of popliteal-femoral saphenous junctions, a horizontal incision somewhat higher up is almost always sufficient for tying the short saphenous vein level with the deep passage. The stripping is downward and invaginated, introducing the pin-stripper right up to the limit of incontinence of the short saphenous trunk. The aponeurosis of the popliteal area must be closed, in order to avoid a fat hernia, and the skin, which is here under high tension, is closed by separate reverse intradermal stitches in non-resorbable thread.

**Preventing hematomy during stripping**

The prevention of hematomy is intraoperative, and is achieved with a 180cm Redon drain perforated along 120cm (Orthothec, Montbéliard, France). The drain is inserted into the stripping tunnel with a guiding thread, and is extracted via the lower stripping incision; continuous suction is immediately turned on. We have used this technique since 1981, when the drains were perforated in a helicoid shape to avoid zones of fragility; drain perforations are now laddered, with no resulting inconvenience. At the start of our experiment, with regard to operations on patients under general anaesthetic, the drain was removed the following day; nowadays, given the limited bleeding caused by local/regional anaesthesia and by invagination, the drain is removed after postoperative compression. Some authors have been able to show [50] that intraoperative bleeding was less in invaginated stripping. Intraoperative bleeding in stripplings performed under general anaesthetic assessed between 100 and 500 ml per side [51] is a problem that has led to numerous innovations above and beyond simple suction [53]. Upward stripping performed at the same time as the bandage is put into place [18, 54, 39] allows the path of the stripping to be immediately compressed. Fixing a pack to the end of the stripper [55, 33, 56, 57], or inserting a pack soaked in thrombase into the saphenectomy tunnel [58] have been suggested. The irrigation of a diluted epinephrine solution along the path of the saphenectomy would appear to be worthwhile and has no real disadvantages [59]. Finally, surgery on varices using a tourniquet, widely used in Germanic countries, has become very easy, thanks to the Löfquist tourniquet (Pomidor, Katrineholm, Sweden). Despite the solidity of plastic strippers, the forced passage of the head of the stripper under the tourniquet has led to the forced breaking of the head of the stripper [23]. Use of a tourniquet allows bleeding to be reduced to 15 ml per side [52, 60].

In fact, the ideal solution which enables one to reduce intraoperative vasomotor paralysis, is to use local/regional anaesthetic by crural block. Ever since we have systematically used this method, intra-operative bleeding has become obsolete.

**Saphenectomy without stripping**

Phlebectomy can be performed without stripping, using a ring stripper [61] the principal of which is similar to that of Volmar's guillotine rings for endarterectomy. Inserted around the saphenous vein at the level of the crossectomy incision, when the ring is gradually pushed downwards it unsticks the saphenous vein down to the level of the knee, without having to make a counterincision (62). In order to perform a long incision, some people have suggested also performing an upward invagination of the remaining saphenous vein [63].
Dressing

The dressing must guarantee a minimum compression of 40 mm mercury in order for the patient to be comfortable when standing. At first, between 1987 and 1993, this was achieved with a preliminary elastocompressive dressing (Sofban-Extensoplast, Fisch, Le Mans, France) applied for 3 days to only the upper part of the thigh, and covered by a long band of Byflex N_ 16 type (Thuasne, St. Etienne, France) for the standing position. The band is kept, from the foot to the top, for 30 days. The disadvantages of this type of dressing (discomfort, phlycten at the pressure points due to the folds of the dressing, difficulty in assessing ideal tension, inefficacy on the thigh of obese patients), have led us to use, since 1994, a double compression with superposed tights of 20 mm mercury [64]. Indeed, studies [65] have shown that the superposing of 2 tights provides a pressure that is equal or slightly higher than the sum of the two separate tights. The two tights are put on in the operating room as an operative dressing, and are kept on for 4 days with the possibility of taking one of during the night if the patient has problems putting up with the pressure in a prone position. The advantage of this type of dressing is that it provides perfectly even pressure, and it is especially effective on the thigh, where hematomy can be considerable with the traditional dressing [66]. The disadvantage are mainly the fact that the tights are not always easily adaptable to the size of the patient. The folds of the tights, especially at knee level, thus create triple pressure which can be dangerous on a popliteal scar (we had two superficial sloughs). Out of 999 cases, Lefebvre-Vilardebo [64] had no cutaneous complications with this type of dressing.

NEUROLOGICAL COMPLICATIONS

For a long time, the neurological complications of stripping have been the cause of the bad reputation of long stripping of the great saphenous vein. Many people have suggested always using short stripping [67, 68] to avoid these lesions, and some [69] have suggested short stripping despite the fact that studies have proven the superior efficacy of long stripping in the treatment of varices. The neurological complications of saphenous stripping are mainly those of lesions of the saphenous nerves.

1. Neurological lesions in great saphenous vein territory

Anatomical studies and dissections carried out on dead bodies after stripping have allowed us to have a clearer understanding of the mechanisms of saphenous neurological injuries. The saphenous nerve (L3-L4) is a sensitive branch of the femoral nerve. It generally crosses the fascia at knee level between the tendons of the gracilis and sartorius muscles and gradually joins up with the great saphenous vein. Other authors, in their studies [70], have shown that the upper exit of the saphenous nerve through the fascia only occurred in 75% of cases; in the other 25% the saphenous nerve crossed the fascia 8 cm below the articular line, and in 10% of cases it did so at mid-leg level. The nerve joins up with the vein at approximately 13 cm below the knee line [71]. In 96% of cases it then remains very close to the saphenous vein in its journey through the leg to the malleolus [71]. It then moves away from the vein at the malleolus or just above it. The risk of neurological injury during stripping may be explained, on the one hand, by the fact that the nerve is so close to the vein (in only 2 cases out of 60 anatomical dissections was the nerve not close to the saphenous vein [71]), and, on the other hand, by the
fact that the vein and the nerve so frequently cross [72] and that there are so many nerve branches crossing the vein [73]. Aigner [70] has shown, out of 25 anatomical dissections, that the layer of fat which separates the nerve and the vein during their journey through the leg was in proportion to the thickness of the panniculus adiposus: on average, it is 3.2 mm thick. Babcock-type strippings, performed upwards on anatomical preparations, almost always led to the anterior tibial nerve branches being torn, sometimes led to the subrotular nervous branch being torn [73], and sometimes to the saphenous nerve being completely torn away below the knee [74]. On the same anatomical preparations, stripping, although it is less aggressive, nevertheless showed pieces of nerve flap on the stripped vein.

During an operation, neurological lesions may relate to a traumatic incision.

- Blind searching and using forceps to attach the head of the stripper through low incision in short stripping under the knee has been known to cause neurological lesion [72].
- The improper ligation of the saphenous nerve with the vein, around the stripper, at the level of the malleolar incision, has sometimes led to actual stripping of the saphenous nerve [72]. Some people, in order to avoid this, have suggested performing a vertical supra-malleolar incision in order to control the saphenous nerve [76], or doing a wide dissection of the saphenous vein at the ankle before inserting the head of the stripper upwards [77].
- In order to avoid this risk, we make the low incision well below the malleolus, level with the inside of the foot, as Holme’s anatomical studies [71] have shown that in 20% of cases, the nerve separates or is already separate from the vein at malleolar level. Indeed, during invaginated stripping, systematic low incision below the malleolus has enabled us to avoid damaging the terminal branches of the saphenous nerve; in our experiments, when the incision was rigorously pre-malleolar, there was damage to these nerves in 2.7% of cases [78].

Neurological lesion is mostly due to the stripping itself.

- Babcock’s exoluminal telescopic stripping. Available studies generally tend to cover exoluminal telescopic stripping of Babcock type. The percentage of lesions varies from 6% to 79%, depending on the study (Table III) [79, 80]. This variation found in the studies is due to a lack of precision in the definition of the neurological problem, be it deficient (anaesthesia), or irritant (paresthesia), and to the duration of the postoperative follow-up and the direction of the stripping. Indeed, before 21 days, the subjective problems (often major) and the transitory objective problems create an artificial increase in the percentage of definitive neurological lesions [73, 81]. Overall, the percentage of neurological lesions in operated patients falls from 24.5% after 15 days to 7.7% after six months [82]. Cormaci’s study [83] of 326 strippings shows that almost all irritant lesions disappear after one year, and that deficient lesions of hypo or anaesthesia type disappear in 75% of cases. The anaesthesia surface area, measured on the eighth day, would seem to be an important factor for prognostics: below 10 cm² it disappears entirely after one year. After two years, problems may be considered to be stable and definitive [76]. The existence of trophic problems or of sequelae of superficial venous thrombosis is an aggravating factor in neurological risk [74] (something which is not always mentioned in studies). Aigner [75] has shown that the layer of fat which
separates the nerve and the vein in the leg, was proportional to the circumference of the calf. He concludes that if the circumference of the calf is greater than 29 cm, the thickness of the layer of fat between nerve and vein is sufficient to avoid saphenous neurological lesion during long stripping. The direction of the stripping plays a major role in the risk of saphenous neurological lesion; it is accepted that upward stripping is more aggressive than downward stripping (Table IV). According to Cox [81], downward stripping leads to a 23% rate of neurological lesions, whereas upward stripping has a 50% rate. Trauma is caused by the insertion of the head of the stripper, upwards, into the upside-down V created by the bifurcating branches of the saphenous nerve. With an identical cutaneous surface area for anaesthesia, downward stripping causes lesions of neuropraxic type, with very major regressive subjective problems at the 3-month stage, whilst upward stripping causes lesions of a tearing type, with definitive objective sensitive problems after 3 months. Aigner [70], in histological examinations of stripped saphenous vein, has shown that nerve fragments are found in 40% of upward stripings, and in 31% of downward stripings. More recent studies [84] confirm the importance of the direction of the stripping with regard to the appearance of deficient sensitive problems, but not in the appearance of irritant neurological lesions. In fact, studies carried out before 3 months do not allow one to properly assess the neurological risks in terms of the direction of the stripping. After 3 weeks, Gasser [85] gives percentages for identical neurological lesions for all types of stripping, whether upward, downward, invaginated or otherwise. Similarly, at 6 weeks, Jacobsen [36] gives percentages for identical neurological lesions whatever the direction of the exoluminal telescopic stripping may be, and again at 6 days, Wellwood [86] highlights the percentages for deficient neurological lesions, showing no significant differences. It would appear to be fully accepted (Table IV) that it is not possible to assess neurological problems before 3 months, and that definitive neurological lesions are significantly affected by the direction of the stripping. Nor is short stripping up to the upper part of the leg without danger, as Negus [68] shows 4.2%, Koyano [87] shows 4.8% and Holme [88] shows 7% of neurological lesions. Whatever the type of stripper used, it would seem clear that the risk of trauma in stripping above all depends on the size of the oliva used [89] and on how flexible it is.

- **Intraluminal telescopic stripping.** The neurological risk in intraluminal telescopic stripping appears to be lower. Indeed, the mantle of telescoped saphenous vein pushed into the corner of the veinous lumen, progresses like a corner-shaped piece of foam ahead of the stripping. Degni [42] reports 0.5% of neurological injuries in 2,000 stripplings performed using this technique. In our experience, stripping with soft oliva or saphenous flap stripping is far less aggressive than Babcock-type exoluminal stripping. Between 1994 and 1995 (Table V), and always downwards, we performed 34 long stripplings with soft oliva and 83 long stripplings with small semi-rigid oliva (8 mm diameter). Objective and subjective examination between the 30th day and the 45th day showed that intraluminal telescopic stripping with soft oliva appeared to be three times less traumatic than the stripping with semi-rigid oliva with regard to the lower third of the leg; on the other hand, the percentage of neurological lesions was identical in short stripping in the middle third of the leg and performed using both methods. Although the data were not sufficient to be able to confirm this impression, stripping with soft oliva would appear to cause less trauma than stripping with rigid oliva. When complete ablation of the great saphenous vein is required, if one does not wish to perform invagination, the best
solution is to perform alternate stripping, with a downward stripping using soft oliva for the upper part, and upward invagination for the lower part, because in our experiment on 160 cases, this method of long alternate stripping only caused neurological lesions in 3.5% of cases.

- **Invaginated stripping.** Invagination is without doubt the method of stripping that involves the least neurological risk: Out of 41 cases of general anaesthesia and 59 cases of pure local anaesthesia, Garofalo [90] does not report any neurological complications after 3 months; Ouvry [33] reports 2.6% of neurological complications, and Staelens [91], out of 1,300 strippings, reports 0.3% of permanent neurological problems. In our experiment on long invaginated stripping [78], we found saphenous nerve lesions in a percentage that was identical for both the first series of patients operated on under general anaesthetic and for the first 200 invaginated strippings under local-regional anaesthetic: 1.2%. In these first 200 cases, we used an antalgesic (AlfintanyI) to treat the particular pain described by the patient as if it were a cramp that totally prevented the invagination from progressing, despite the perfectly efficient femoral block. This blockage always occurs when the return bend is blocked in the upper third of the leg. When the stripping is continued in the opposite direction, one can sometimes break through the blockage, but it is often necessary to section one of the saphenous collaterals in order to ease the cramp and to continue the stripping. The fact that the saphenous nerve becomes tense may be due to a branch of the saphenous nerve being strangled by a saphenous venous collateral (Figure 4). This collateral may directly strangle the saphenous nerve when the nerve perforates the aponeurosis at the lower position [70]. Out of the 1,650 invaginated strippings performed since, recognition of this "cramp signal" (encountered 15 times) has allowed us to avoid damaging the saphenous nerve in cases of blockage. It now appears possible, without any neurological risk, to perform saphenous invagination on the leg as long as one uses local-regional anaesthesia by crural block, and as long as one looks out for this "cramp signal".

Neurological lesion sometimes occurs without long saphenous stripping [84]. It may follow on from injury from a Muller's hook used to recover, on the thread, a residual portion of the saphenous trunk, or to perform ablation of a collateral. When it is a question of the saphenous nerve, and if it is not immediately recognised, the injury may be confused with a lesion due to stripping. It may concern an accessory nerve branch, in which case local anaesthesia is often transitory (7% in our study) [78].
2. Neurological lesions in popliteal area surgery

These are rarely reported (3% of short saphenous nerve lesions for Negus, out of 96 cases [92]. In our study we never encountered any neurological complications in surgery on the popliteal cavity for short saphenous incontinence, when such surgery was performed under local anaesthetic, without electric knife, and with x3.5 binocular loupe. The only damage to occur to the saphenous nerve was during operations under general anaesthetic (0.5% out of 180 cases) [93]. More recently, following an operation for incontinence caused by a short saphenous vein directly joining the common fibular nerve, we had a traumatic lesion of the accessory nerve of the short saphenous vein and of the cutaneous-peroneal nerve. This extremely rare anatomical situation [12], caused by the embryological persistence of the post-axial vein, can be recognised during preoperative treatment. In the two cases that we have encountered, the short saphenous vein was situated at the level of the popliteal area (very laterally away).

However, lesions caused by stripping are more frequent. Fortunately, in the vast majority of cases, the incontinence of the short saphenous vein only concerns the upper part of the calf - 93% in our study, 46% for Koyano [87]. At this level, in its sub-aponeurotic journey, the short saphenous vein is separated from the short saphenous nerve by an aponeurotic division. No neurological lesion was reported after invaginated stripping of the upper part of the short saphenous vein (319 cases). The risk is higher for the lower part of the leg, where the short saphenous vein, the short saphenous nerve and the short saphenous accessory are closely linked. Out of 342 short saphenous refluxes (Table VI), we only performed 23 long invaginated stripplings on the bottom third of the short saphenous vein. The neurological lesions only concerned long invaginated stripplings: one lesion in the accessory of the short saphenous nerve, and one lesion in the short saphenous nerve. Koyano [87] reports 20.8% of neurological lesions out of 24 long stripplings (non-invaginated).

Anaesthesia

Pure local anaesthesia has been used for long saphenous stripping since 1953 [94-96]; it is still widely used by some [24, 25, 45-47]. For an operation, although the level of lidocaine [97] or mepivacaine [98] in the blood remains well below toxic levels, this type of anaesthesia requires large volumes of anaesthetics. The 3-in-1 crural block [99] is inaccurate, and also consumes a large volume of anaesthetic products. In our experiment we always used the femoral block with location by electrical stimulators (Stimuplex, Braun, Melsungen, Germany) which is a development of the technique originally created by Greenblatt [100] and Chapmann [101]. We use unsheathed needles (22G x 50 -Térumo, St Quentin, France) [102]. Electrostimulation not only locates the main trunk, but also the 3 sensitive branches of the femoral nerve. All varix operations, without exception, can be performed in this way. We have systematically used the femorall block since 1992, as it offers several advantages compared to other forms of anaesthesia. First of all, it rarely leads to vasomotor paralysis; secondly the preservation of proprioceptive sensitivity (via proper co-operation between the surgeon and the patient) enables one to avoid neurological damage to the saphenous nerve during invaginated stripping at leg level; finally, it is easy to perform with ambulatory treatment. Monolateral selective peridural is a useful alternative with regard to patient comfort [103] but it is less easy in ambulatory treatment, and does not, in the intraoperative stage, allow one to monitor the tension of the saphenous
nerve during stripping. For patient comfort, the use of mepivacaine in the femoral block provides a better proprioceptive quality.

**Ambulatory surgery**

Ambulatory surgery is something that we used by respect for patient comfort, and because it requires rigorous operative procedures [38, 104-106]. Out of 1,500 long saphenous strippings performed under femoral block between 1988 and 1992 [30], we had: as from 1991, only 10% of patients in hospital for one night after the operation (of which half were for non-medical reasons - comfort, transport, family situation, 21% because they lived in nearby suburbs, 74% lived up to 110 km away, and 4% up to 223 km away). A comfortable and painless operation is vital if the operation is to be performed in ambulatory fashion. The femoral block, given the reduced bleeding and the fact that neurological damage can be avoided, is a step in the right direction. In 1994, a survey of 1,340 patients, carried out on the 30th day, showed that 74.5% of patients had been able to go about their normal domestic business the day after the operation, 15% after 5 days, and 10.5% over one week later. More recently, in 1995, out of 450 patients questioned on the 30th day, approximately one quarter had talked to their general practitioner, or telephoned their postoperative surgeon. Out of these 25.5%, only 3.5% did so for reasons of postoperative pain. Overall, ambulatory surgery was never responsible for any particular postoperative complication.

**RESULTS**

Long-term results are very difficult to assess. There are no studies of long-term results that include the spontaneous factors of the evolution of the illness (genetics, lifestyle, hormones, multiparity), but that also bear in mind the precision of the operative indication, for the simple reason that the systematization and the reliability of the preoperative Doppler ultrasonic hemodynamic examinations are very recent. This lack of precision is illustrated by the differences in the percentages of recidivation that have been found (Table VII) [107-109]. Out of 164 operations with a 10-year follow-up, Laurikka [110] has shown that poor results are not due to the competency and experience of the surgeon, but to error in operative indication. As far as indications are concerned it would appear to be accepted that long stripping gives better results than short stripping [69], and that results are better when one performs a stripping in addition to a simple phlebectomy crossectomy [111, 112]. However, some authors [113, 114] have shown that there were identical results for crossectomy-stripping and crossectomy-perforate ligation. If we look at the available data [115], results would appear to degenerate during the years of postoperative follow-up, although some authors [65] have shown that results remain stable after 6 years. These conflicting results demonstrate the difficulty of integrating preoperative hemodynamic results. In fact, no study of results covers selective surgery; most studies cover (but without any precision) varices of the limbs and long stripping, whereas in our experiment [44] in 1994, out of 607 preoperative reports (Table VIII), long stripping was only justified in 45% of the cases. In 26% of the cases the great saphenous vein was fully continent, and in 24.6% of cases it was only incontinent over a portion of its length at the time of the operation. Koyano's study [87], on postoperative plethysmographic measures, is the only one to have shown that results were better in the group of patients with incomplete saphenous reflux, and who were operated on in a selective manner. It is certain that varicous exereses that are as accurately adapted to hemodynamic complications as possible, will lead to better results in the future.
Unfortunately, this attitude, which depends on the development of Doppler machines, is too recent for us to be able to assess results, which in varix surgery can only be judged after 10 years.

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### PASSAGE OF THE STRIPPER DEPENDING ON THE DIRECTION IN WHICH IT IS INSERTED

92/93 (n = 1300) 94 (n = 191) significant difference $X^2 = 121.98$ p<0.001

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UPWARD</strong></td>
</tr>
<tr>
<td><strong>BLOCKAGE /</strong></td>
</tr>
</tbody>
</table>
Types of Invaginated Stripping

1988 - 1992 (n = 1500)
45% of intermediate rupture

Table 2

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>98%</td>
<td>Complete invagination</td>
<td>70%</td>
</tr>
<tr>
<td>45%</td>
<td>Partial invagination</td>
<td></td>
</tr>
<tr>
<td>28%</td>
<td>Exoluminal telescoping</td>
<td></td>
</tr>
</tbody>
</table>

Frequency of Saphenous Neurological Lesions in Exoluminal Telescoping Stripping (Babcock)

? = details not provided by the authors

Table 3

<table>
<thead>
<tr>
<th>Direction of Stripping</th>
<th>Number of Strippings</th>
<th>% of Lesions</th>
<th>References</th>
<th>Postoperative Follow-up</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downward</td>
<td>26</td>
<td>23%</td>
<td>Wellwood [86]</td>
<td>3 months</td>
<td>1975</td>
</tr>
<tr>
<td>Upward</td>
<td>26</td>
<td>50%</td>
<td>Wellwood [86]</td>
<td>3 months</td>
<td>1975</td>
</tr>
<tr>
<td>Upward</td>
<td>57</td>
<td>30%</td>
<td>Munn [69]</td>
<td>3 months</td>
<td>1981</td>
</tr>
<tr>
<td>?</td>
<td>778</td>
<td>76.7%</td>
<td>Lavorato [79]</td>
<td>9-10 years</td>
<td>1983</td>
</tr>
<tr>
<td>?</td>
<td>112</td>
<td>7.1%</td>
<td>Soether [74]</td>
<td>?</td>
<td>1987</td>
</tr>
<tr>
<td>?</td>
<td>141</td>
<td>27.7%</td>
<td>Koyno [87]</td>
<td>1 years</td>
<td>1988</td>
</tr>
<tr>
<td>Downward</td>
<td>80</td>
<td>39%</td>
<td>Holme [88]</td>
<td>3 months</td>
<td>1990</td>
</tr>
<tr>
<td>?</td>
<td>59</td>
<td>79.6%</td>
<td>Caseilla [76]</td>
<td>9 months - 21 years</td>
<td>1992</td>
</tr>
<tr>
<td>Upward</td>
<td>144</td>
<td>33%</td>
<td>Laurikka [110]</td>
<td>10 years</td>
<td>1992</td>
</tr>
<tr>
<td>?</td>
<td>963</td>
<td>6.6%</td>
<td>Gritchley [80]</td>
<td>8 years</td>
<td>1994</td>
</tr>
<tr>
<td>Upward</td>
<td>454</td>
<td>14.5%</td>
<td>Gasser [85]</td>
<td>21 days</td>
<td>1995</td>
</tr>
</tbody>
</table>

Comparative Study of Deficient (Anaesthesia) Saphenous Neurological Lesions, Depending on the Direction of Exoluminal Telescoping Stripping (Babcock) and of Postoperative Follow-up

* = type of neurological lesion not explained by authors
(1) = insignificant difference
(2) = significant difference \( X^2 = 26.13 \ p<0.001 \\
x\% = \text{percentage identical for both directions of stripping (figure not given by the author)}

**TABLE 4**

<table>
<thead>
<tr>
<th>year</th>
<th>reference</th>
<th>upwards</th>
<th>downwards</th>
<th>postoperative follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>WELLWOOD (1) [86]</td>
<td>33 % (n = 30)</td>
<td>40 % (n = 30)</td>
<td>6 days</td>
</tr>
<tr>
<td>87</td>
<td>RAMASAstry (1) [73]</td>
<td>50 % (n = 14)</td>
<td>42.8 % (n = 14)</td>
<td>15 days</td>
</tr>
<tr>
<td>95</td>
<td>GASSER (1) * 85</td>
<td>14 % (n = 126)</td>
<td>13.5 % (n = 166)</td>
<td>21 days</td>
</tr>
<tr>
<td>75</td>
<td>JACOBSEN (1) * 36</td>
<td>x % (n = 28)</td>
<td>x % (n = 28)</td>
<td>1.5 months</td>
</tr>
<tr>
<td>74</td>
<td>COX-WELLWOOD (2) [82 86]</td>
<td>50 % (n = 26)</td>
<td>23 % (n = 26)</td>
<td>3 months</td>
</tr>
<tr>
<td>87</td>
<td>RAMASAstry (2) [73]</td>
<td>71 % (n = 14)</td>
<td>0 % (n = 14)</td>
<td>3 months</td>
</tr>
<tr>
<td>94</td>
<td>DOCHERTY (2) [84]</td>
<td>26.9 % (n = 62)</td>
<td>10.6 % (n = 66)</td>
<td>3 months</td>
</tr>
<tr>
<td>87</td>
<td>RAMASAstry (2) [73]</td>
<td>42.8 % (n = 14)</td>
<td>0 % (n = 14)</td>
<td>6 months</td>
</tr>
</tbody>
</table>

**PERCENTAGE OF SAPHENOUS NEUROLOGICAL LESIONS DEPENDING ON THE TYPE OF OLIVA USED IN INTRALUMINAL TELESCOPING STRIPPING**

1994 - 1995 % of neurological lesions number of strippings
insignificant difference: Fischer test

**TABLE 5**

| long stripping semi-rigid oliva | 9,6 % | n = 83 |
| long stripping soft oliva      | 2,9 % | n = 34 |
| short stripping semi-rigid oliva| 3,3 % | n = 59 |
| short stripping soft oliva     | 3,7 % | n = 240 |
| short stripping soft or semi-rigid oliva + invagination | 3,1 % | n = 160 |

**TYPE OF NEUROLOGICAL LESION DEPENDING ON THE LENGTH OF THE INVAGINATED STRIPPING CARRIED OUT ON THE SHORT SAPHENOUS VEIN**

(1) = significant difference: Fischer test \( p = 0.0094 \)

**TABLE 6**
### FREQUENCY OF VARICOSE RECURRENCE AFTER LONG STRIPPING OF THE GREAT SAPHENOUS VEIN

**TABLE 7**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Year</th>
<th>%</th>
<th>(n)</th>
<th>Recurrence</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>RILVIN [67]</td>
<td>1975</td>
<td>6%</td>
<td>1708</td>
<td>récidive clinique</td>
<td>5 - 10 years</td>
</tr>
<tr>
<td>JACOBSEN [107]</td>
<td>1979</td>
<td>10%</td>
<td>161</td>
<td>récidive clinique</td>
<td>3 years</td>
</tr>
<tr>
<td>MUNN [69]</td>
<td>1981</td>
<td>36%</td>
<td>57</td>
<td>récidive clinique</td>
<td>3 - 4 years</td>
</tr>
<tr>
<td>ROYLE [108]</td>
<td>1986</td>
<td>18%</td>
<td>367</td>
<td>récidive clinique</td>
<td>5 years</td>
</tr>
<tr>
<td>HAMMARSTE N [109]</td>
<td>1990</td>
<td>12%</td>
<td>24</td>
<td>récidive clinique</td>
<td>5 ans</td>
</tr>
<tr>
<td>LAURIKKA [115]</td>
<td>1994</td>
<td>12%</td>
<td>164</td>
<td>récidive réintervention</td>
<td>10 ans</td>
</tr>
</tbody>
</table>

Separation of the types of great saphenous vein and short saphenous vein insufficiency (preoperative Ultrasound Doppler Mapping)

**TABLE 8**

<table>
<thead>
<tr>
<th>TYPE OF INCONTINENCE</th>
<th>n = 471</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>long reflux</td>
<td>277</td>
<td>45</td>
</tr>
<tr>
<td>short reflux below the knee</td>
<td>87</td>
<td>14</td>
</tr>
<tr>
<td>high partial reflux</td>
<td>29</td>
<td>4,7</td>
</tr>
<tr>
<td>low partial reflux</td>
<td>21</td>
<td>3,4</td>
</tr>
<tr>
<td>middle partial reflux</td>
<td>13</td>
<td>2,1</td>
</tr>
<tr>
<td>LS collateral reflux</td>
<td>23</td>
<td>3,7</td>
</tr>
<tr>
<td>first collateral reflux</td>
<td>21</td>
<td>3,4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TYPE OF INCONTINENCE SHORT SAPHENOUS VEIN</th>
<th>n = 136</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>great saphenous vein + short saphenous vein reflux</td>
<td>20</td>
<td>3,3</td>
</tr>
<tr>
<td>short saphenous vein reflux</td>
<td>47</td>
<td>7,7</td>
</tr>
<tr>
<td>Condition</td>
<td>Count</td>
<td>Value</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Popliteal perforator vein reflux</td>
<td>5</td>
<td>0.8</td>
</tr>
<tr>
<td>Isolated varices with continent saphenous vein</td>
<td>64</td>
<td>10.5</td>
</tr>
</tbody>
</table>