6 Saphenous Sparing Strategy in the CHIVA Context

Erika Mendoza

Abbreviations

AASV	Anterior accessory saphenous vein
GSV	Great saphenous vein
PASV	Posterior accessory saphenous vein
RET	Reflux elimination test
SFJ	Sapheno-femoral junction
SPJ	Sapheno-popliteal junction
SSV	Small saphenous vein

6.1 Evidence-Based Rationale of the Strategy

Varicose veins are still of unknown reason. Though there has been progress in understanding through applied physics and anatomy since the Doppler and later the duplex ultrasound allowed to analyse recirculations, though histology and tissue mediator changes offer possible explanations, the last reason for the dilatation and flow reversion in superficial leg veins is still to be found.

The destruction of reflux pathways was a good solution over many years, when no other instrument was available to stop the consequences of venous reflux, like skin changes, pain and ulceration.

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Already early investigations about the effect of compression on the venous wall histology which nearly recovered to normal after 7 days of compression hosiery [1] contradicted the dogma that saphenous wall degeneration in varicose disease is irreversible. All the CHIVA research published later (see Chaps. 1 and 10) and a Cochrane review [2] state that recidives are less frequent if saphenous veins are spared during surgery. Thus, and analogous to all the other surgical fields, the organ preservation should at least be given a chance.

6.2 Instructions for Readers

Persons confronted with CHIVA for the first time often argue that it is too much of information to learn the shunt types and then to learn how to treat them. Trying to prevent this confusion, the authors have explained the shunts in Chap. 3 (see Sects. 3.7–3.9). Based on these shunts, Franceschi developed the treatment strategies for haemodynamic flow correction [3–5]. They are based on four principles (see Sect. 6.3.4) and then applied to the shunt types. The schematic flow images throughout the chapter are based on those explained in Chap. 2 (see Fig. 2.5) and also used throughout Chap. 3.

This chapter starts with the international definitions used in the CHIVA context to avoid semantic confusion, which are the bases for

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CHIVA (Sect. 6.3). Then, the different approaches to the most frequent shunt types are first analysed "in general" (Sect. 6.4).

Adapting to the usual treatment thinking, which is anatomy-oriented, the different management options of the pathological compartment jumps are described separately first:

- N1 → N2 = deep vein to saphenous vein at the junction (see Sects. 6.5 and 6.7)
- P → N2 or N3 = pelvic reflux into saphenous vein or tributary (see Sect. 6.6)
- Refluxing N2 (Sect. 6.8)
- N1 → N2 = deep vein to the saphenous vein via a perforating vein (see Sect. 6.9)
- N1 → N3 = deep vein into a tributary via a perforating vein (see Sect. 6.9)
- N2 → N3 = saphenous vein into a tributary (see Sect. 6.10)

Please note that re-entry pathways are considered when designing the strategy for the patient but are never treated!

Finally, the acquired knowledge is applied to the treatment decisions in every shunt type in Sect. 6.11 with clinical examples.

The chapter finishes with tips of how to get started, explanation to handle difficult situations like the treatment after superficial vein thrombosis and large varicose veins and outcome evaluation.

6.3 Bases of the CHIVA Strategy and International Terminology

At the World CHIVA Congress in 1998 in Paraná (Argentina), a consensus was reached within the European CHIVA Association to develop a multilingual terminology for anatomical and physiological nomenclature in the context of CHIVA. There had previously been difficulties in comprehension, because of the differing meanings of a given word in different languages. The definitions given below are a basic assumption for international understanding of the CHIVA method.

The recirculation types were further elaborated at the World CHIVA Congress in May 2002 in Berlin/Teupitz; the results of this consensus conference are summarised in Sects. 3.7 and 3.8.

6.3.1 Venous Competence or Incompetence

Venous incompetence is the inability of a vein to provide unidirectional flow towards the heart, appropriate to the heart's functioning, haemodynamic reserves and thermoregulation and independent of the bodily attitude.

Competent venous flow is:

- Unidirectional
- Towards the heart
- Independent of the position of the body

It is adapted to:

- Heart's function
- Thermoregulation
- Haemodynamic reserves

6.3.2 Anatomical Concepts

The muscle fascia covers the muscles. The saphenous fascia covers the saphenous veins and together with the muscle fascia forms the saphenous compartment. The saphenous veins lie directly on the muscle fascia and are covered by the saphenous fascia, so that they course through a fascial tunnel (see Sect. 2.2.3). For this reason, they are also known as "interfascial" veins.

Venous networks: For the purposes of the CHIVA method, veins are divided into four groups according to their position relative to these fasciae, originally with the abbreviation R for "réseau" from French and in English with the abbreviation N for "network".

Classification N1–N4

N1 Network: All the veins which course in the deep compartment delimited by the muscle fascia, like deep veins and perforating veins

N2 Network: All the veins which lie directly on the muscle fascia and below the membranous layer or saphenous fascia, like interfascial veins (saphenous veins, Giacomini vein, proximal segment of the accessory anterior saphenous vein)

N3 Network: All the veins which course between the fasciae and the skin: arch veins, tributaries and all the tiny reticular veins, capillaries and spider veins

N4 Network: These are specific N3 veins that serve to connect N2 veins

- Longitudinal N4: Connections between the same N2 vein (like those connecting two points on the great saphenous vein)
- Transversal N4: Connections between different N2 veins (like those connecting the great saphenous vein with the small saphenous vein)

The vein of Giacomini is sometimes completely interfascial (N2) but functionally connects two different N2 veins (GSV, SSV), so functionally it is a transversal N4 vein.

6.3.3 Haemodynamic Concepts

The blood flow in a vein is defined by:

1. Direction of flow (see Sect. 3.2)
2. Source of its contents (see Sect. 3.4)
3. Volume
4. Pressure

The first two aspects are most important for the purposes of learning about the CHIVA strategy.

6.3.3.1 Direction of Flow

Anterograde or antegrade flow moves in a physiological direction and follows the rule: "big" N to "small" N, superficial to deep:

- N3 – N2 – N1 tributary drains to saphenous vein to deep vein via junction or perforating vein
- N3 – N1 tributary drains to deep vein via perforating vein
- N2 – N1 saphenous vein drains to deep vein via junction or perforating vein

Retrograde flow moves in a pathological or "reverse" direction.

> Note: retrograde is not the same as towards the foot. For example, in the upper veins of the confluence of superficial inguinal veins, flow towards the foot is not pathological.

6.3.3.2 The Source of Its Contents

The usual source of the content of a vein is from superficial veins to deep veins in case of antegrade flow (see Sect. 6.3.3.1).

The reflux source is the point at which blood starts flowing against the compartment rule, it enters one vessel from another in retrograde flow, jumping from a small N into a bigger N.

- N1 → N2 from deep vein into saphenous vein via the junction or a perforating vein
- N2 → N3/N4 from a saphenous vein into a tributary
- N1 → N3 from the deep vein via a perforating vein into a tributary

6.3.3.3 Drainage from the Varicose Vein: Re-entry Points

The re-entry point is the point where the blood in pathological flow re-enters a competent vessel, through which it is drained from the leg to the heart, where the blood changes anatomic compartments again in the physiological way from a big N to a small N (see Sect. 3.5).

- N2 – N1 from a refluxing saphenous vein via a perforating vein to the deep vein
- N3 – N2 from a refluxing tributary into a saphenous vein
- N3/N4 – N1 from a refluxing tributary via a perforating vein into the deep vein

The re-entry point is very often a perforating vein.

The draining vessel, for example, the perforating vein, which is primarily healthy, is thus permanently overloaded by the additional blood volume of the recirculation.

A distended re-entry perforating vein is not primarily diseased but is simply, like the deep veins, overloaded by the reflux volume.

6.3.3.4 Shunts

A shunt is a short circuit or diversion from one vascular region to another, consisting of a reflux source and a re-entry point (see Sects. 3.7–3.9).

A shunt may be open or closed, depending on whether or not the reflux returns to its original starting point.

Closed shunt: The blood returns to its starting point, overloading the venous system. The patient presents recirculation through a closed circuit (see Sects. 3.7.1 and 3.8).

Open shunt: The vein system has a reflux source and a re-entry point, but the blood does not complete a circuit. It can be just diverted (open deviated shunt; see Sect. 3.7.2) or bypassing an obstruction (open bypassing shunt or open vicarious shunt; see Sect. 3.7.3)

Classifying Recirculations (Closed Shunts) into Shunt Types (see Sect. 3.8)

Shunts are classified into six different types, called shunt types, according to their origin, course, implied networks and re-entry pathways, especially with reference to their treatment. The shunt type is defined according to the principal recirculation pathway; subsidiary circuits may be connected to the principal recirculation.

6.3.3.5 CHIVA Strategy

The CHIVA strategy consists of four parts (for further explanations, see Sect. 6.3.4):

- Dividing the hydrostatic pressure column
- Interrupting the recirculations
- Maintaining re-entry points
- Eliminating non-draining N3 networks

1. **Dividing the hydrostatic pressure column**

   Interrupting the reflux source is dividing the pressure column between the next superior deep vein valve and the re-entry point of the recirculation. Note: In case no iliacal valve exists and the sapheno-femoral junction is incompetent, the pressure column in the incompetent N2 (GSV) and depending N3 (varicose tributary) starts at the right heart atrium. Divisions are possible at each pathological compartment jump (N1 – N2, N2 – N3) and at branching points of refluxing tributaries, as well as below a draining perforating vein in the course of a refluxing N2 or N3 segment.
2. **Interrupting the recirculations**

   The main object of the CHIVA strategy is to avoid recirculation circuits by means of ligations and interruptions, so as to remove the patho-haemodynamic cause of varicose veins: the pathological jumps of anatomic compartments.
3. **Maintaining re-entry points**

   Re-entry points allow the blood to drain from the veins of the superficial networks (N2 and N3) into the deep system (N1) and therefore must not be ligated.
4. **Eliminating non-draining N3 networks**

   Large tributaries usually have muscle cells in the wall, allowing a good recovery of diameters after volume overload was interrupted. On the contrary, smaller tributaries or those with slow flow in preoperative conditions (poorly drained) usually do not. The recommendation is therefore to spare saphenous veins (N2), optionally also large tributaries (N3), combined with exhairesis or sclerotherapy of reticular varices. Exhairesis of all tributaries whilst maintaining the saphenous trunk veins and sclerotherapy of varicose reticular and spider veins are both compatible with CHIVA.

6.3.3.6 Different Types of Intervention

CHIVA 1: Interruption of the proximal reflux source of the principal and optionally also the subsidiary recirculations.

CHIVA 2: Interruption of the N2 – N3 jump without interruption of the N1 – N2 jump as a

first step in case of shunt type 3 (RET positive; see Sect. 3.8.9). Check up after some months, and if necessary interruption of the primary reflux point, if it has not become competent.

CHIVA 1 + 2: "Conservative, non-haemodynamic procedure"

Simultaneous ligation of the primary and distal reflux sources with shunt type 3 instead of CHIVA 2 and later on second step. The result is an undrained system with numerous superficial vein thrombosis and recurrences in tributaries. Applied in some countries due to reimbursement necessities. The proximal saphenous trunk is left in the leg, but no longer participates in leg drainage. This is therefore described as an undrained system or a non-haemodynamic procedure.

Devalvulation: Resection of the valve in a competent saphenous vein to avoid a non-drained situation in case of CHIVA 1 + 2: The saphenous vein (N2) can then drain into the next perforating vein, avoiding the superficial vein thrombosis and permitting a drained situation for the saphenous vein.

Crossotomy: Interruption of the N1 − N2 jump at the sapheno-femoral junction (SFJ) at the level of the fossa ovalis without interruption of the tributaries of the groin. They are left draining into the great saphenous vein (GSV) avoiding a thrombosis of the latter.

6.3.4 CHIVA Strategy

Claude Franceschi explained four bases of the CHIVA strategy in his first publication in 1988. Since then, they have remained unaltered:

1. Interrupt recirculation circuits by closing the escape point
2. Divide the pressure column
3. Maintain re-entry routes
4. Eliminate non-draining tributaries

The result is:

- Only flow from superficial to deep (N3 − N2 − N1)
- No flow in circles (closed shunts)
- No volume overload in superficial leg veins

Sometimes, to achieve this result, blood will flow towards the food for a short segment in an N3 or N2 vein. The direction of flow plays not a big role, as long as the amount of blood is adapted to the vein diameter, the re-entry for the blood is adapted to the volume and thus a drained situation is created. After the interruption of the SFJ (see Fig. 6.1) and during diastole, blood in the proximal GSV will flow with a flat curve towards the foot (which means the "wrong" direction) until it finds the next perforating vein (see also Sect. 4.11.1 and Fig. 4.40). Blood from tributaries (N3) will drain through the GSV (N2) into the deep vein via a perforating vein (see Fig. 6.1b). There will be no pathologic compartment jumps and no volume overload, as the GSV was designed to drain the blood of the tributaries and the deep veins to drain the blood of the leg.

This fact could be demonstrated by investigations measuring diameters of the common femoral vein beneath the level of the confluence of the GSV (SFJ) 6 months and 5 years after applying CHIVA for GSV reflux. The common femoral vein is dilated in case of chronic venous insufficiency as compared to healthy individuals and reduces its calibre after surgery [6–8]. If the retrograde drainage of the tributaries through the GSV into the deep veins would overload the femoral vein, the diameter would not reduce to normal after CHIVA. At short term (6 months, [7]), the calibre reduction to normal values [9] could be demonstrated; this was still true in midterm evaluation (10 years, [8]), even though 20% of the investigated patients showed a slight recurrence.

6.3.4.1 Interruption of Recirculation Circuits

As with all other surgical options for the treatment of varicose veins, the basic object of the CHIVA strategy is to interrupt the recirculation circuit.

The simplest way to do this is to interrupt the first reflux source. This prevents the blood from flowing from a low N to a higher one. In other words, the blood can no longer flow out of the

deep veins into the superficial system nor from the saphenous vein into the tributaries (see Fig. 6.1). In this way, not only the recirculation is interrupted, but volume overloading in the superficial vein system is also eliminated.

As a result of the reflux point interruption, the blood can only flow from a "big N" into a "little N" (see Fig. 6.1b). A certain volume of blood flows down towards the foot in the superficial system below the interruption; however, a downward flow is not necessarily a reflux. Reflux consists of blood flowing antegrade during muscular systole (in the affected vein or another), which flows backwards in the diseased vein during muscular diastole, generally towards the foot. This usually involves mainly the passage of blood from a low N (like a deep vein, N1) into a higher one, for example, to a saphenous vein (N2). Thus, blood flows back into the superficial system after it has already entered the deep system; this is undesirable since its physiological objective should be the most direct route to the heart (see Sect. 3.2.1).

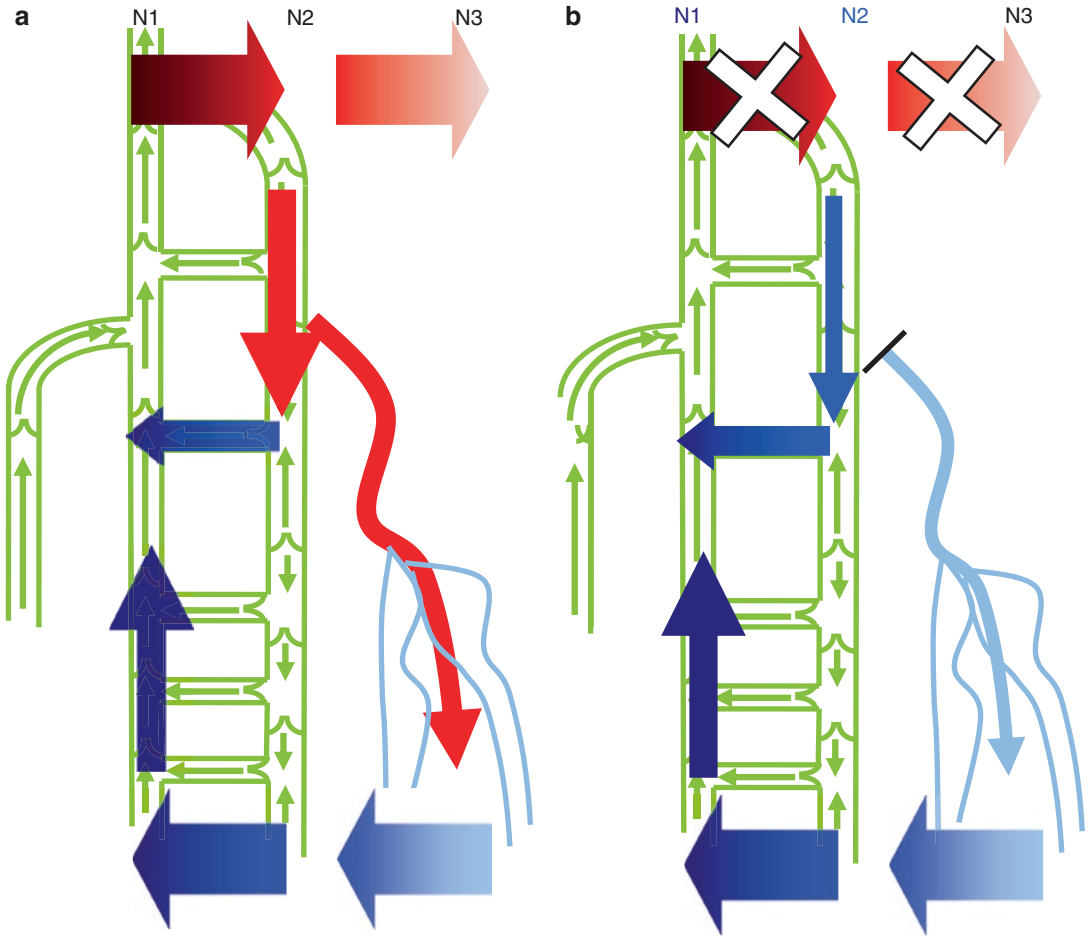

Fig. 6.1 (**a**) Shunt with escape point N1 → N2 at the SFJ, reflux into the GSV (red arrow), second escape point N2 – N3 at knee level into a refluxing tributary (red arrow), re-entry perforating vein on GSV (N2 – N1) and re-entry perforating vein on the tributary (N3 – N1) (blue arrows). (**b**) The base of the CHIVA strategy: Interruption of pathological compartment jumps: – N1 → N2 and N2 → N3. Flow after treatment of a varicose vein with CHIVA: The blood flows towards the foot for a short segment but never from N1 to N2 or N2 to N3. The total blood volume in the leg is reduced to normal. With permission by [10]

Reflux is the basic signal indicating recirculation: blood in circular flow, which never leaves the leg. If the primary reflux source is interrupted however, as by interruption of the SFJ, this will allow the blood from the tributaries of the confluence of superficial inguinal veins to flow towards the foot through the GSV as far as to the next perforating vein. In this case there is flow towards the foot but no recirculation exiting the deep vein and therefore no reflux. The blood from the capillary networks which joins the epigastric and pudendal veins (N3 veins) flows through a saphenous vein (N2) into the deep vein system (N1), without any occurrence of circular flow. The blood simply flows through a slightly longer segment of N2 (see Fig. 6.1).

This footward-directed flow after an interruption of the SFJ is often misinterpreted when investigating patients after CHIVA. The same happened to Dwerryhouse [11] when they aimed to compare stripping with crossectomy without stripping (which is not CHIVA!!). They found a footward-directed flow and described this as a reflux, so all the patients were catalogued as "failure". If the upwards exit is closed and the saphenous vein is still patent, the blood has to leave it at a point downwards. And this necessarily induces a footward flow.

The Italian language has an ideal word for this non-refluxing retrograde flow after interruption of the SFJ: "deflusso", which could be translated into English as "downflow" or "deflux".

The return of varicose veins to their normal calibre is the logical result of this relief from overloading [7, 8]. This reduction in calibre functions best in the saphenous trunks. Perhaps one reason for this is the additional anchorage of the saphenous veins by the saphenous fascia, as well as the fact that the walls of the saphenous veins contain more muscle cells than epifascial tributaries (see Sect. 2.6).

Keeping the saphenous veins is useful not only for later use of the vein as bypass material but also, more importantly, in order to preserve drainage routes for the superficial vein system of the leg and preventing recidives without escape point [12].

6.3.4.2 Division of the Hydrostatic Pressure Column

In the standing subject, varicose veins carry the blood into the deep vein system by the easiest route, as dictated by gravity. Even if the recirculation is stopped, blood from the tributaries will prefer this easier way just down through the superficial vessels. For this reason, it is important, whenever possible, to interrupt refluxing segments below confluences with tributaries or perforating veins, so that the blood is forced to find a route to the deep vein system through perforating veins, instead of remaining in the superficial vein system and flowing down to the foot. Division of the pressure column is particularly important for a good cosmetic result in the calf region.

6.3.4.3 Keeping Re-entry Points Untouched

Re-entry perforating veins must be maintained untouched in order to provide drainage from the superficial vein system. They must be preserved as part of the CHIVA strategy.

The diameter of the drainage pathway, for example, the re-entry perforating vein or the draining tributary, must be sufficient to drain the flow from the refluxing proximal vein, without creating a bottleneck for the backflow. This is one of the most important concepts in CHIVA treatment. In the first days after intervention, the treated vein is still distended and fills with blood from antegrade tributaries when standing. If the blood from this vein cannot drain well through perforating veins after the intervention, superficial thrombosis is very likely to develop.

The Calibre of the Draining Vein Must Match That of the Drained Vein

A velocity profile during duplex examination in PW mode can help in decision-making. If the

tributary planned to be interrupted is closed by digital compression, the proximal segment of the vein from which this tributary is filled with reflux must still show a good reflux curve. If the reflux ceases (almost) completely under digital compression of the tributary, the digitally closed vessel is the principal drainage pathway and must not be interrupted in order to prevent a superficial vein thrombosis in the saphenous vein (see Fig. 6.2).

6.3.4.4 Eliminating Non-draining Venous Networks

The non-draining tributary network consists of veins which are distended by reflux with a poor drainage (see Sect. 3.2.3). The blood flows slowly in these veins, and they do not recover to normal calibre properly after volume overloading is relieved. They are mostly veins from the region of the accessory anterior saphenous vein (AASV) or reticular varices. It is sometimes necessary to carry out a mini-phlebectomy to optimise the cosmetic outcome or to apply sclerotherapy later on, if they still persist at time of follow-up. Large, winding saphenous tributaries do not fall into this group. They generally reduce their calibre well after volume overload is relieved. If the patient wants to see immediate results, the tributaries can also be phlebectomised, whilst the saphenous trunks are maintained.

Thus, the mini-phlebectomy or sclerotherapy of tributaries is not contradictory with CHIVA as often supposed. CHIVA aims to preserve the ***saphenous*** draining pathways.

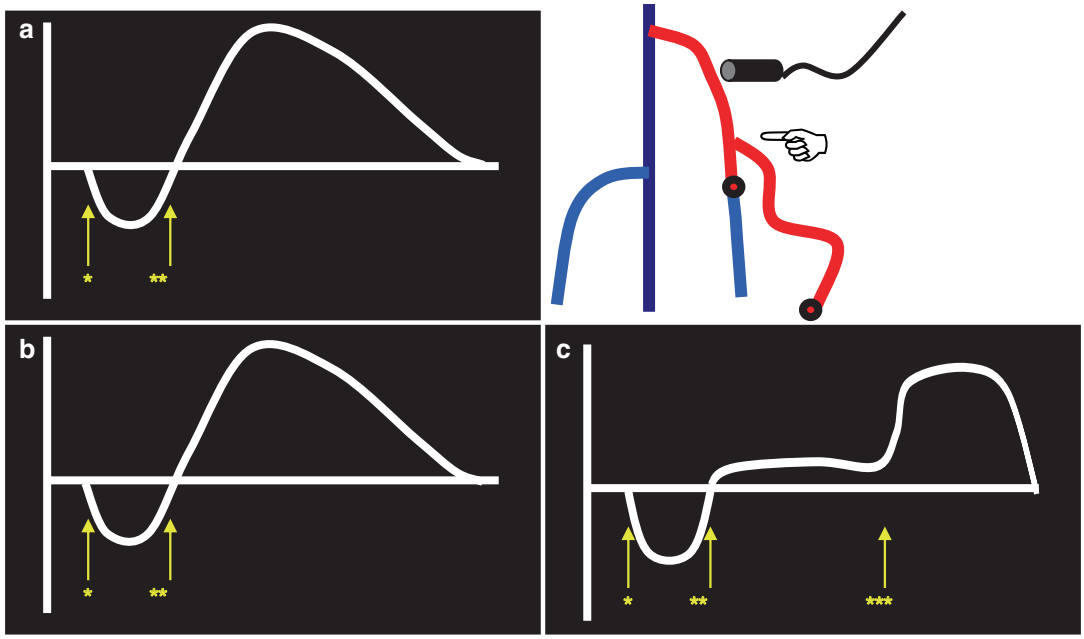

Fig. 6.2 Testing the drainage capacity of a perforating vein or a tributary prior to its interruption. This is performed occluding the tributary with a finger. (**a**) Flow in the saphenous vein without manipulation (left) and setting of veins, finger and probe (right) (as Fig. 3.31). (**b**) Flow in the saphenous vein whilst pressing on the tributary, no alteration in the curve: The perforating vein on the GSV is able to drain the blood from the saphenous vein. (**c**) Flow in the saphenous vein whilst pressing on the tributary: The perforating vein is not large enough to drain the blood from the saphenous vein. This tributary should not be touched simultaneously to the junction in order to avoid a thrombosis in the GSV. *Forefoot elevation, **forefoot goes down again and relaxes, ***finger releases the pressure on the tributary. With permission by [10]

6.4 CHIVA Strategy Depends on the Saphenous Perforating Veins

The most important distinction between two recirculation systems prior to decide which CHIVA strategy to apply is to find out whether there is or not a draining perforating vein link between the refluxing saphenous vein and the deep vein. This will differentiate the most frequent shunt types (see Fig. 6.3): shunt type 1 (with perforating vein drainage) from shunt 3 (without perforating vein drainage). The difference can easily be found with the reflux elimination test (RET; see Sect. 3.8.9 and Fig. 3.31): digitally pressing on the refluxing tributary and testing if the GSV is still refluxing—in case of draining perforating vein on the GSV, the reflux will be persistent also under digital compression of the tributary (RET negative), and in case of no perforating vein, the reflux will stop (RET positive). The same criterion differentiates shunt 4 (with perforating vein, RET negative) from shunt 5 (without perforating vein drainage, RET positive).

After the first description of CHIVA, it soon became obvious that the situation defined as shunt type 3 made some problems: The CHIVA concept proposes to interrupt the veins at their pathological compartment jumps. This would mean to close the SFJ and the origin of the tributary (see Fig. 6.3). This works perfectly in case of shunt type 1 (see Fig. 6.3 left). But when closing the junction and the origin of the tributary, the

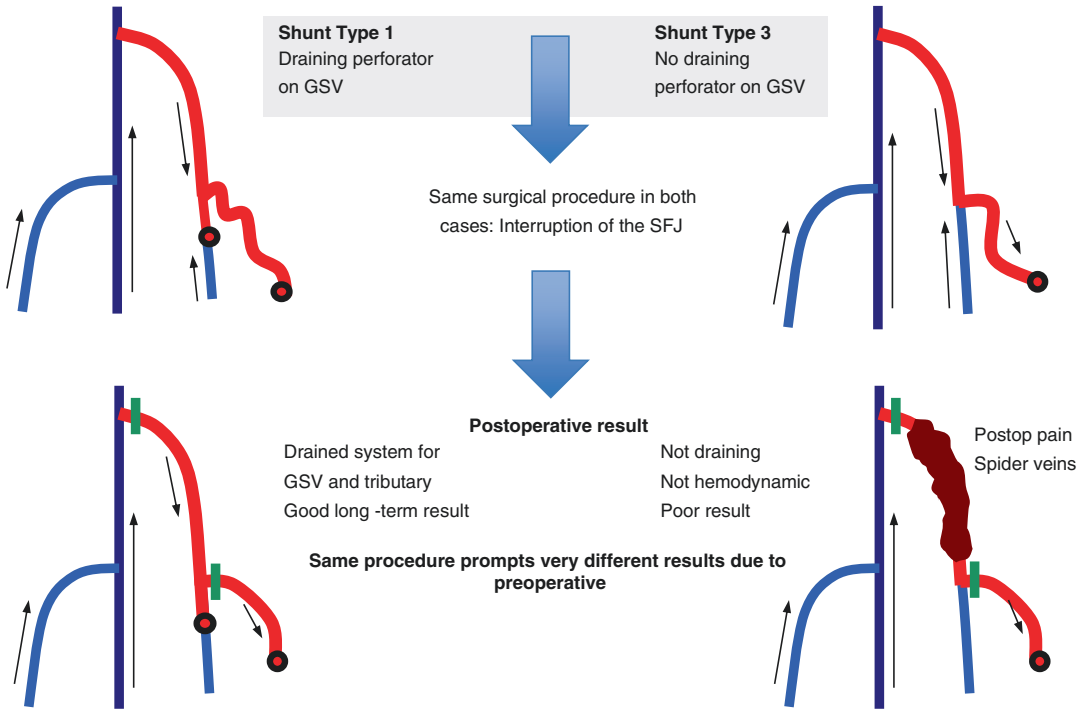

Fig. 6.3 Comparison between results when applying the same treatment to shunt types 1 and 3 (after Cappelli, presented in Boston 2013). With permission by [10]

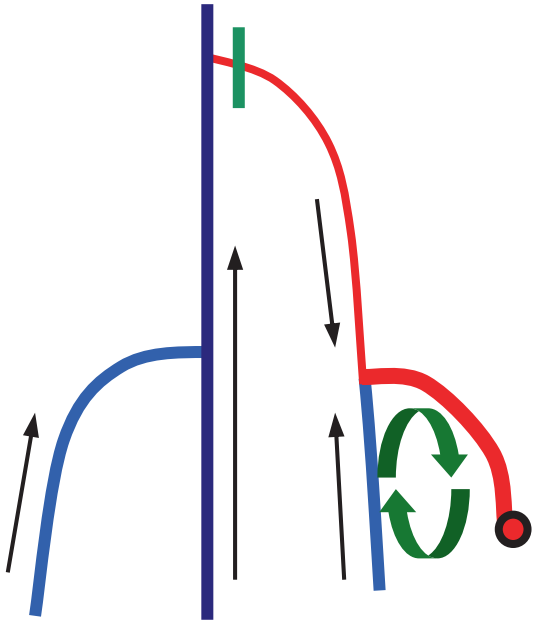

Fig. 6.4 Interruption of the SFJ: The GSV will reduce its diameter and have retrograde, non-overloading flow. As a result, we find a recirculation from the distal saphenous vein into the tributary. N1 ⊣ N2 → N3 – N1. With permission by [10]

segment of saphenous vein between both interruptions would remain "non-drained" in case of shunt type 3 (see Fig. 6.3 right) (see also Sect. 6.11.3 shunt type 3).

If only performing crossotomy to the situation on the right part of Fig. 6.3 aiming to avoid the possible GSV thrombosis, a recirculation in the tributary would remain (see Fig. 6.4). Of course, the reflux volume would be reduced significantly, changing the shunt type 3 into a shunt type 2. In case of C4–C6 situation, when an improvement of clinics is the major focus, this will help. But in case the cosmetic result is a priority of the patient, this way will not be not satisfactory, as the tributary would remain visible.

6.4.1 CHIVA in Two Steps or "CHIVA 2"

To solve this problem, CHIVA in two steps was developed and called "CHIVA 2" in the CHIVA meeting in Passenans, 1994. In the first step, only the N2 → N3 compartment jump is treated with interruption of the tributary or tributaries that drain the reflux from the saphenous vein (Fig. 6.5) (see Sect. 6.11.3 Shunt 3). As a result, we will find a flow conversion in the great saphenous vein to antegrade in the days after the intervention (see Sect. 6.4.1.1). This situation can remain stable after some weeks, or a recurrence of reflux through the junction appears either draining through a perforating vein (see Sect. 6.4.1.2) or draining through a new tributary (see Sect. 6.4.1.3). As this remodelling takes some time, the control ultrasound should be performed about 3 months after the intervention or even later on. In case of permanent antegrade flow, patients at the control used to be also clinically free of complaints. On ultrasound, a diameter reduction of GSV can be assessed and antegrade flow. On the contrary, in case of GSV reflux, patients feel some discomfort at the disconnection point (CHIVA 2 point), and in ultrasound, the GSV is still enlarged and refluxing.

This model of "working in two steps" is difficult in countries, where vein surgery is hospital based and the availability of surgical theatre slots is difficult. That is why other options have been developed, like devalvulation or CHIVA 1 + 2 (see Sect. 6.12).

Of course, all expressed ideas concerning "CHIVA 2" apply also to the SSV, but there is no published data to tell about a percentage of cases.

As after the first step of CHIVA 2 there could be a saphenous vein thrombosis in the proximal segment of the GSV ascending into the femoral vein, special attention has to be paid to thrombosis risk factors and to heparin prophylaxis for 10–14 days after intervention. This is especially true in case of diameters of GSV at proximal thigh larger than 8.5 mm (see Pintos, Sect. 10.1.4).

6.4.1.1 Flow Conversion in the Saphenous Vein

Forty-two percent of patients with a shunt type 3 have an antegrade flow after tributary disconnection in shunt type 3 after 1 year; this is stable in

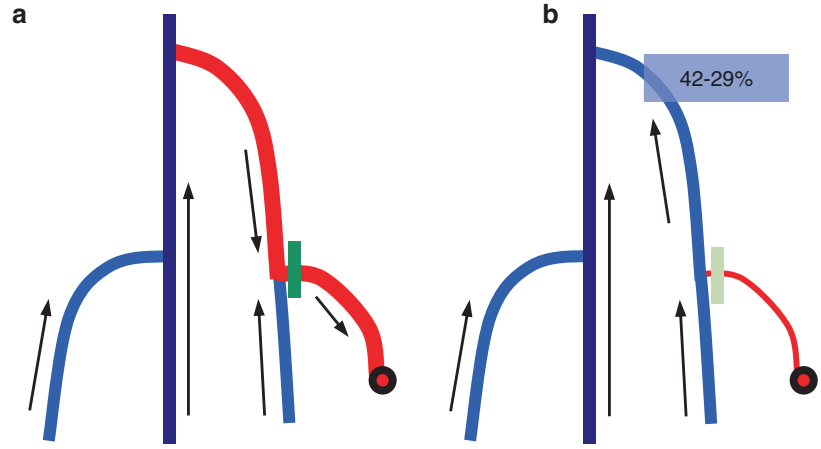

Fig. 6.5 (**a**) First step of CHIVA 2: interruption of the tributary with flush ligation at the jump N2 – N3 (dark green) N1 → N2 ⊣ N3 – N1 (**b**) Flow conversion in GSV in 42% (1 year) and 29% (3 years) after first step of CHIVA 2. The tributary drains its physiologic blood load through the perforating vein, no recirculation, no varicose vein. The light green line at the N2 – N3 jump interruption represents the fact that this interruption is "old" N1 → N2 ⊣ N3 – N1 results in no reflux—no second step is necessary. With permission by [10]

29% of patients after 3 years [13]. This means that the GSV will be flowing physiologically with antegrade drainage (see Fig. 6.5) in midterm in about a third of all cases treated with CHIVA 2 first. There are some factors favouring this evolution:

- Small diameter of affected GSV
- Short refluxing segment of GSV (refluxing tributary at the proximal thigh)

Obviously, this result is the optimum desirable and really meets the saphenous sparing condition with an evolution to normality after the intervention.

6.4.1.2 Persistent Reflux Draining Through a Perforating Vein

In case of reflux recurrence in the GSV after tributary interruption, the reflux will find a new reentry pathway. This might be a perforating vein existing on the saphenous vein which enlarges to drain the reflux volume. That means that a shunt type 3 has been converted into a shunt type 1 and can be treated as such with a crossotomy (see Fig. 6.6).

6.4.1.3 Persistent Reflux Draining Through a New Tributary

The other option after the first step of CHIVA 2 with recurrent reflux in the GSV is a new refluxing tributary draining the refluxing blood from the saphenous vein, which most often fills the first existent dilated tributary at some point. The patient returns reporting that nearly nothing happened apart from a slight reduction in the tributary or a disappearance of a part of the tributary and often reduction of symptoms. The reflux amount in the GSV in the months after the first step is most often less than before the intervention (see Fig. 6.7a). Again, a first step of CHIVA 2 can be performed interrupting the new refluxing tributary, expecting antegrade flow in the GSV (see Fig. 6.7b). In the authors' personal experience, more than half of the patients had no flow reversal in the GSV after the second intervention of a tributary.

Another option is to perform a crossotomy and to leave a reflux into the tributary, if the patient is not too bothered by the fact that a tributary will be seen (see Fig. 6.7c).

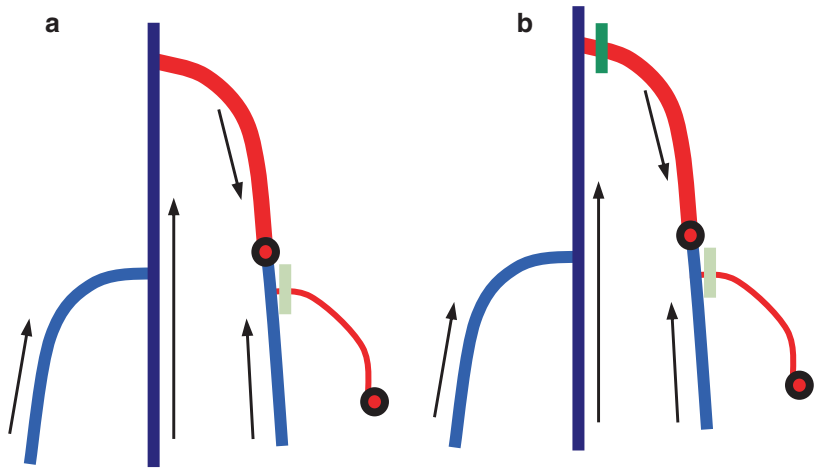

Fig. 6.6 (**a**) After the first step of CHIVA 2 (light green line), the tributary has reduced calibre, draining through a perforating vein. The GSV is still refluxing, draining through a new widened perforating vein on the GSV—which might be proximal to the tributary interruption point (as depicted) or distally. N1 → N2 ⊣ N3 – N1 results in N1 → N2 – N1 (**b**) In this situation, the interruption of the SFJ (dark green line) completes the treatment and is called the second step of CHIVA 2. Blood from the proximal segment of the GSV will then drain through the perforating vein. N1 ⊣ N2 – N1. With permission by [10]

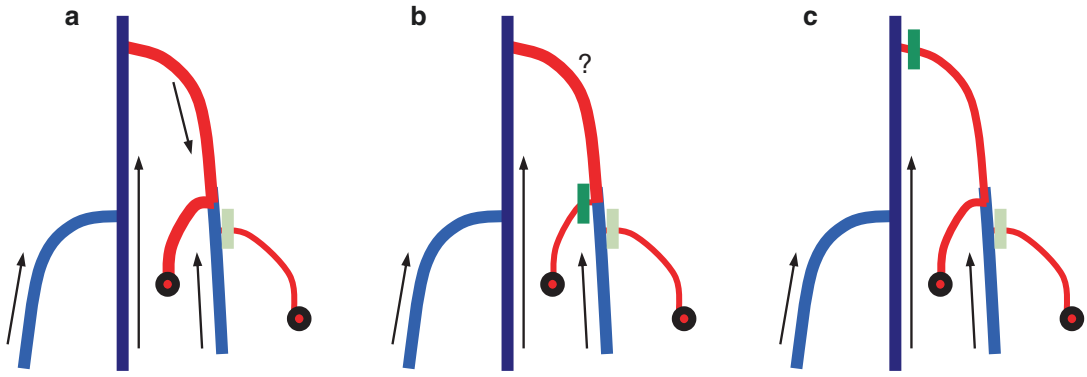

Fig. 6.7 (**a**) After the first step of CHIVA 2 (light green line), the tributary has reduced calibre, draining through a new refluxing, which might be proximal to the tributary interruption point (as depicted) or distally and that might join the pre-existent tributary (not shown). N1 → N2 ⊣ N3 – N1 results in N1 → N2 → N3 – N1 (**b**) One option is the interruption of the new refluxing tributary with the problem of the uncertain flow reversal in the GSV. (**c**) The third option is the interruption of the SFJ, resulting in poor cosmetic results (see Fig. 6.4). With permission by [10]

6.4.2 Devalvulation of GSV

To avoid the treatment in more than one step in case of shunt type 3 and fearing proximal thrombosis in the GSV after applying first step of CHIVA 2, the "devalvulation" was proposed by Claude Franceschi in the CHIVA Meeting (1994 Passenans, France) and has been further developed. The aim is to create a draining situation for the GSV destroying the valve(s) in the GSV further down to the draining tributary until the level of the next GSV perforating vein (see Sect. 7.9). Depending on the preoperative finding, there are three situations to use a devalvulator, called Type

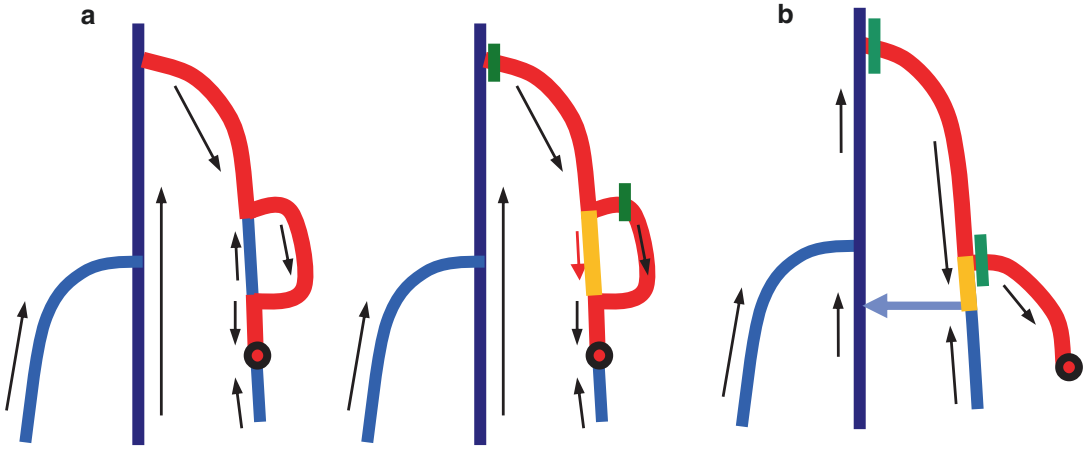

Fig. 6.8 Devalvulation in shunt 3. (**a**) Devalvulation Type A left: preoperative situation with two refluxing segments on the GSV and one interposed competent segment, as well as a perforating vein draining the distal segment located on the GSV. Right: crossotomy and tributary disconnection (green lines) and devalvulation (orange) of the competent segment between the two refluxing GSV segments. The upper GSV is now drained through the distal re-entry perforating vein. N1 N2 N3 – N2 – N1 (**b**) Devalvulation Type Bp and B: management of shunt type 3 (as in Fig. 6.3 upper right) with crossotomy, tributary disconnection and devalvulation (orange line) of the GSV between the tributary disconnection point and the next perforating vein (blue arrow). If there is a large perforating vein preoperatively, this type of devalvulation is called Bp, and if not, it is called B. N1 N2 N3 – N1. N1

With permission by [10]

A, Type Bp and Type B (see Fig. 6.8), based on the presence or not of a draining perforating vein.

- Type A is the case of a multisegmental reflux in GSV. The devalvulation will be applied on the competent GSV segment between the two refluxing segments (see Fig. 6.8a).
- Type Bp applies to a shunt type 3. Distal to the refluxing tributary, on the antegrade segment of the GSV, a perforating vein is visible (most often the proximal paratibial or Boyd) (see Fig. 6.8b).
- Type B: Same situation as Bp (shunt type 3), but no visible distal perforating vein on the GSV. In this case, we assume the presence of the perforating vein at the typical locations (see Fig. 6.8b).

According to the results of the group in the Vall d'Hebron University Hospital (Barcelona) presented 2011 in Napoli by JM Escribano, the devalvulation worked in all three groups without statistical significant differences. They developed draining re-entry perforating veins achieving a drained system after one step.

The devalvulation has some advantages: It allows to treat a shunt type 3 in one session, being sure to achieve a drained situation.

6.5 Management of the Sapheno-femoral Junction

The great saphenous vein (GSV) is very often affected in varicose disease. The reflux source can be located at the groin with different variations, depending on the conditions of the terminal and preterminal valve, as well as of the competence of the groin tributaries at the sapheno-femoral junction (SFJ) [19, 20] (see Fig. 6.9a and Sect. 4.4).

Treatment decisions depend not only on the described conditions but also on the draining

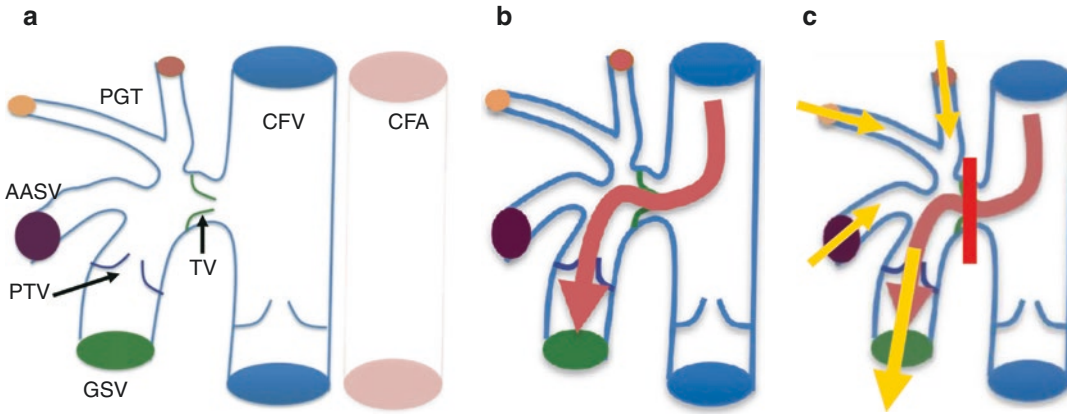

Fig. 6.9 (**a**) Schematic representation of the sapheno-femoral junction: CFA, common femoral artery; CFV, common femoral vein; PGT, proximal groin tributaries; AASV, anterior accessory saphenous vein; GSV, great saphenous vein; TV, terminal valve; PTV, preterminal valve. This schematic representation is the basis of the next figures. It has to be remarked that there are lots of anatomic variations in the sapheno-femoral junction and not always all the tributaries are present and or there is more than one of each. (**b**) Incompetent terminal and preterminal valve at the SFJ (for legends, see figure **a**). The reflux emerges from the femoral vein (blue) and trespasses the terminal valve and the preterminal valve. The GSV (green) is filled with reflux. The accessory anterior saphenous vein (violet) and the other tributaries of the groin (pudendal, epigastric and circumflex veins—yellow and orange) are competent. (**c**) The crossotomy is represented by a red line: interruption of the GSV at the very level of the ostium. The reflux path is interrupted; the draining path from the tributaries into the patent GSV is possible (yellow arrows) and washes the distal GSV avoiding thrombosis. With permission by [15]

pathways of the reflux (see Sect. 6.4). In case no draining perforating vein is found on the saphenous vein, possibly the tributary will be treated first and the SFJ later on only in case it is still refluxing (see "CHIVA in two steps", Sect. 6.4).

6.5.1 Incompetent Terminal and Preterminal Valve

This section deals with the treatment of a reflux in the GSV caused by incompetent terminal and preterminal valves (see Fig. 6.9b).

Claude Franceschi introduced the concept of "crossotomy" in 1988 [5], which means to interrupt the saphenous vein from the deep vein at the level of the ostium, leaving the groin tributaries untouched (see Fig. 6.9c). The groin tributaries drain retrogradely through the saphenous vein and further down into the deep vein via a perforating vein. They wash out the GSV avoiding a thrombosis (see Sect. 7.2). This interruption was described as double ligation with interruption between both—later on modified adding clips, with and without interruption but always leaving the drainage of the junction tributaries into the distal GSV.

In some countries, this technique is not reimbursed by the public health-care system (like in Germany); thus the crossectomy with ligation of all the groin tributaries excepting the posterior accessory saphenous vein is often performed, surprisingly with little superficial thrombosis as a consequence, but destroying the drainage pathway of the pudendal, epigastric, accessory anterior and circumflex veins. This is not CHIVA at its pure form.

Further developments, like endoluminal heat or glue application, are studied in the context of CHIVA [14]. Long-time results are still missing. For further information, see Sect. 7.13.

The SFJ will be treated in the CHIVA concept in case of:

- Incompetent terminal and preterminal valve.
- In addition: draining perforating vein further down on the saphenous vein (RET negative).
- If no draining perforating vein is found on the GSV (RET positive), consider first to treat the tributary or apply devalvulation (see Sect. 6.4).

6.5.2 Incompetent Anterior Accessory Vein

In case of an incompetent terminal valve and competent preterminal valve, the reflux from the deep vein fills a short segment of the GSV and then escapes into the anterior accessory saphenous vein. The AASV is one of the most important tributaries of the GSV. Its pathology is often cosmetically bothering. There are lots of possible combinations of reflux with the GSV and thus lots of treatment options at groin level. Usually the AASV feeds a long visible tributary net, which often does not disappear completely after reflux abolition. So, a simultaneous sclerotherapy or phlebectomy should be proposed to the patient; alternatively the sclerotherapy could be applied after some months, as the AASV will have reduced its calibre (see Sect. 7.12).

The anterior accessory saphenous vein (AASV) has a proximal interfascial segment (N2). Along its course, it pierces the fascia to become extrafascial (N3) in most cases. Sometimes it stays interfascial. It has an inter- or epifascial communicating vessel to the GSV. This connecting vessel has to be considered when applying CHIVA.

A classification into a shunt type 1 or 3 is difficult, because the vein is interfascial in its origin (N2) and only in its course it turns epifascial (N3) sometimes without any branching.

6.5.2.1 Incompetent Terminal and Competent Preterminal Valve

Reflux from the common femoral vein (N1) with incompetent terminal valve into the GSV (N2), escaping into the AASV. Competent preterminal valve with no reflux down the GSV. The AASV is always subfascial in the first segment, becoming extrafascial at a certain point of its course; thus it might be considered an N3 with a first segment as N2, using N2/N3 to signal this (Fig. 6.10a).

The treatment is a flush ligation of the AASV at the confluence with the GSV, also called lateral crossotomy. The SFJ itself must not be ligated, since in that case the distal, antegrade GSV would have no drainage, causing a non-drained situation for the GSV and possibly thrombosis in a healthy vessel.

6.5.2.2 Incompetence of a Subfascial AASV with Refluxing Tributary Leaving the Fascia

Incompetent terminal valve with reflux from the femoral vein (N1) into the GSV (N2). Competent preterminal valve with reflux escaping through refluxing AASV. In this case, the AASV has a complete subfascial course; thus it is an N2 vessel. Further down the reflux drains into an extrafascial tributary (N3); the AASV is competent in the footward segment (see Fig. 6.11a).

In this case the AASV may be considered as an N2 with reflux into a tributary. The interruption of the tributary "en niveau" is often enough to cause a flow reversal in the AASV (see Fig. 6.11b). Otherwise the vein has to be treated as described in Sect. 6.5.2.2: lateral crossotomy.

6.5.2.3 Incompetence of the AASV with Simultaneous Incompetence of the GSV and Draining Perforating Vein on GSV

Reflux from the common femoral vein (N1) with incompetent terminal and preterminal valve, into the GSV (N2) above or above and below the

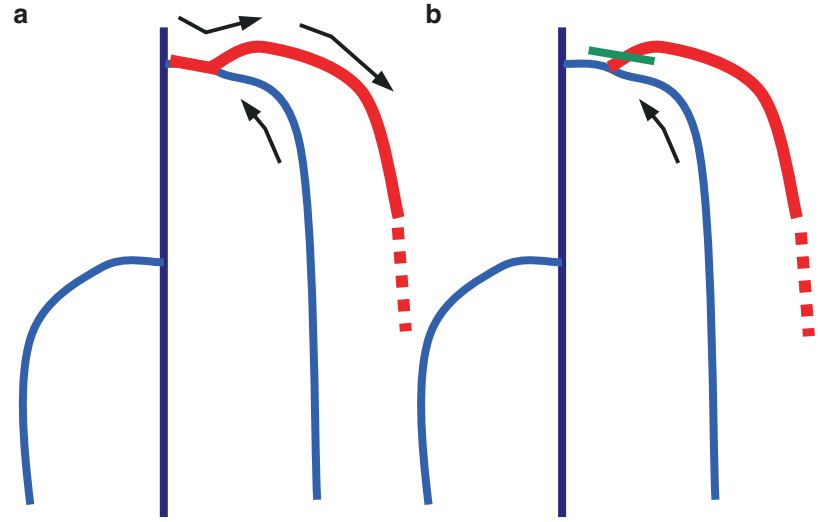

Fig. 6.10 (**a**) Incompetence of the terminal valve, competence of the preterminal valve with reflux escaping through AASV. N1 → N2 (GSV) → N2/3 (AASV) – … (**b**) Treatment option: flush ligation of the AASV at the GSV, sometimes called "lateral crossotomy". N1 ← N2 ⊣ N2/3 – … With permission by [10]

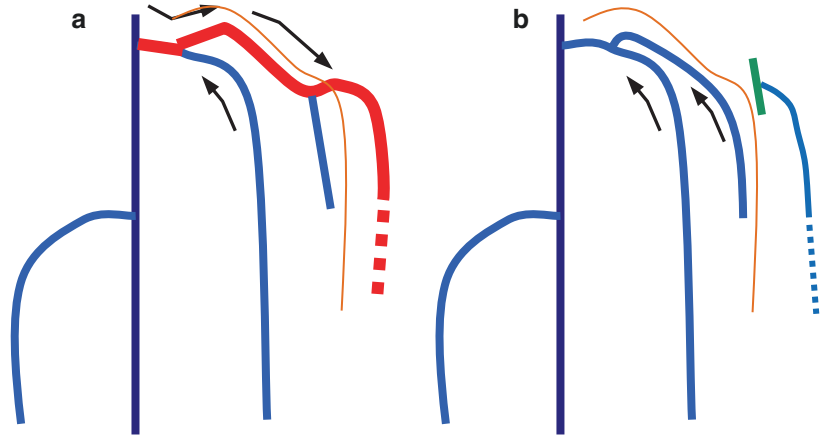

Fig. 6.11 (**a**) Incompetence in the proximal section of the AASV. The reflux leaves the AASV and exits from the fascia (brown line) through a tributary. N1 → N2 (GSV) → N2 (AASV) → N3 (**b**) Situation after interruption at the tributary with flush ligation at the level of the AASV. The interfascial lateral accessory saphenous vein and the SFJ have become competent again. N1 ← N2 (GSV) ← N2 (AASV) ⊣ N3 With permission by [10]

knee. Drainage through perforating vein from the GSV (shunt type 1). In addition, reflux into the AASV (N2/N3) as refluxing tributary (see Fig. 6.12a).

The treatment consists in the interruption of the SFJ (crossotomy) with simultaneous interruption of the AASV (see Fig. 6.12b).

6.5.2.4 Incompetence of the AASV with Simultaneous Incompetence of the GSV and No Draining Perforating Vein on the GSV

Reflux from the common femoral vein (N1) with incompetent terminal and preterminal

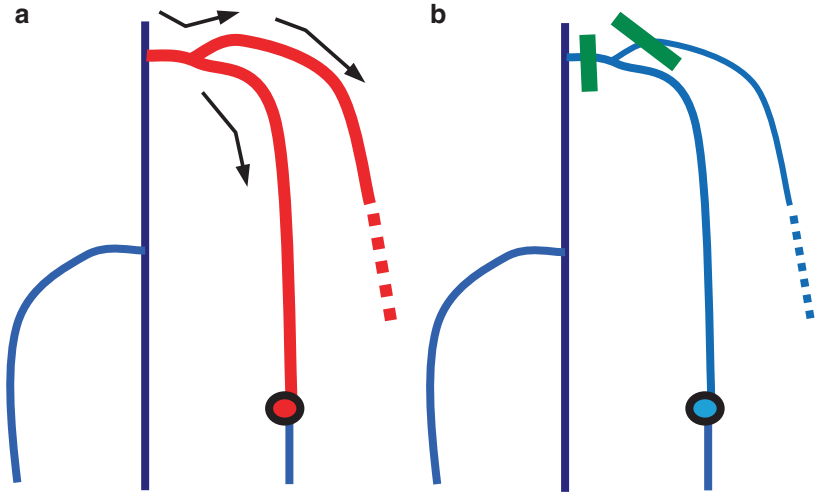

Fig. 6.12 (**a**) Reflux in GSV and AASV with incompetent terminal and preterminal valve, draining perforating vein on the GSV. N1 → N2 – N1 ↘ N2/3 – N1 (**b**) After crossotomy with additional interruption of the AASV calibre reduction in GSV and AASV. N1 ⊣ N2 – N1 ↘ N2/3 – N1. With permission by [10]

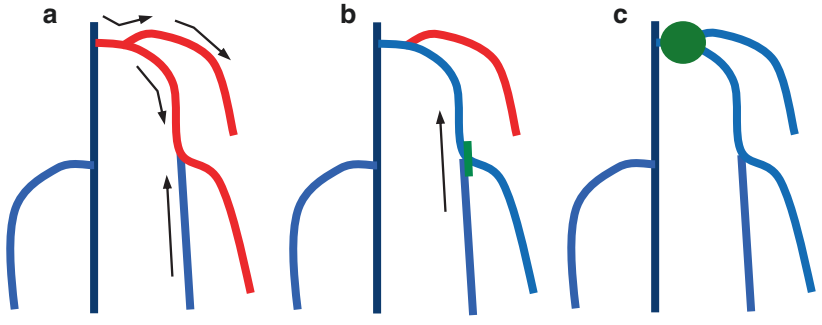

Fig. 6.13 (**a**) Shunt type 3 with two tributaries: one at distal thigh and one is the AASV. N1 → N2 → N3 – N1 ↘ N2/3 – N1 (**b**) Treatment in case of little reflux: interruption of the tributary with flow reversal in the GSV in about 50% of cases. Later the AASV could be treated with sclerotherapy in case of little reflux or with interruption at the confluence with the GSV. N1 → N2 ⊣ N3 – N1 ↘ N2/3 – N1 (**c**) Treatment in case of dilated veins: crossotomy including the interruption of the AASV and perhaps later sclerotherapy of the tributary. N1 ⊣ N2 → N3 – N1 ↘ N2/3 – N1. With permission by [10]

valve, into the GSV (N2) above or above and below the knee. Drainage through a tributary from the GSV (shunt type 3). In addition, reflux in the AASV (N2/N3) as refluxing tributary (see Fig. 6.13a).

Usually in case of shunt type 3, the treatment is flush ligation of both tributaries, followed by crossotomy after some months in over 50% of cases (see Sect. 6.4.1). As the AASV has to be ligated in the groin itself, in case of a further need of a crossotomy after some months, a re-intervention in the groin would be necessary and has to be performed in scarred tissue. That is why this approach is no good option.

There are two alternatives:

- In case of little reflux in GSV and AASV, with small diameters (Fig. 6.13b), perform first flush ligation of the distal refluxing tributary (at the thigh or calf), but not touching the AASV. Follow-up: In case of competent GSV, then perform a phlebectomy or sclerotherapy of AASV. In case of still refluxing GSV (terminal and preterminal valve), perform a crossotomy and interruption of the AASV in a second step.
- Dilated GSV and AASV with large amount of reflux (Fig. 6.13c): treatment of the SFJ as first step with crossotomy and interruption of AASV. Depending on the calibre reduction of the tributary, it may be treated after some months with sclerotherapy or phlebectomy or flush ligation.

6.5.2.5 Reflux in the AASV with Drainage into the GSV at Mid-thigh via a Communicating Vein

Reflux from the common femoral vein (N1) through the SFJ into the GSV (N2), escaping into the AASV. The preterminal valve is competent; thus the GSV at proximal thigh is competent but is filled refluxingly via a connecting vein from the AASV at mid-thigh (See Fig. 6.14a).

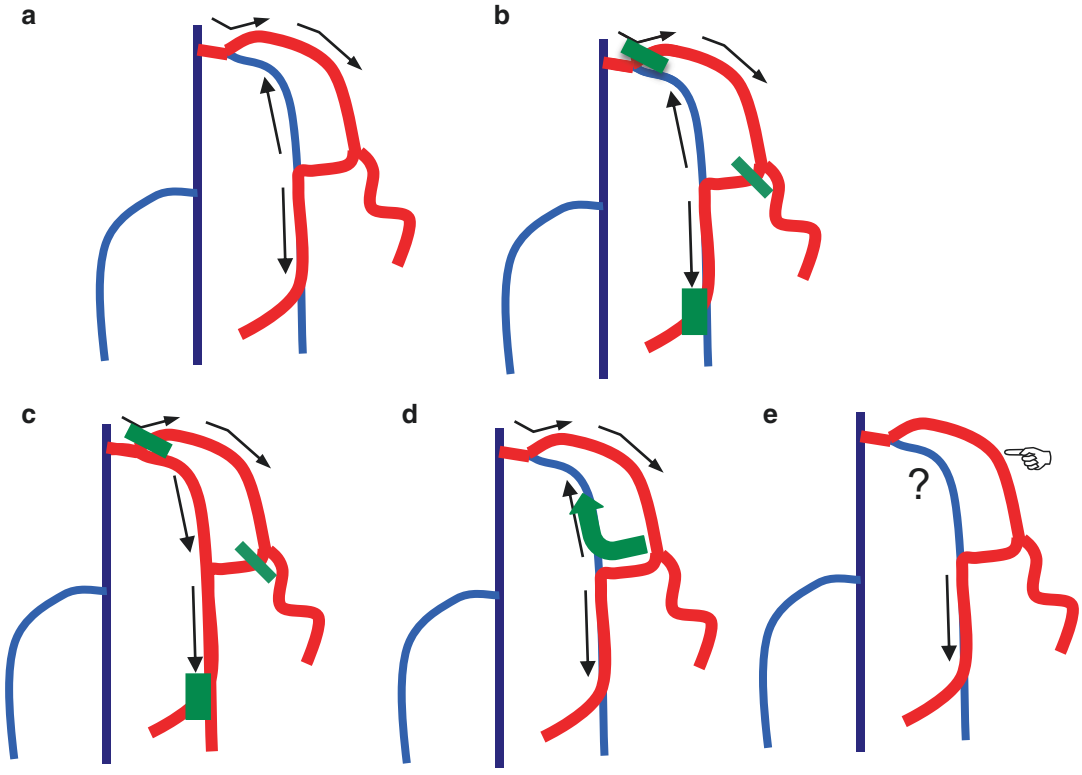

Fig. 6.14 (**a**) Reflux from deep vein into GSV and AASV, competent GSV at proximal thigh. AASV branches, one tributary fills the GSV with reflux. N1 → N2 → N3 – N1 ↘ N2 → N3 – … (**b**) Treatment of the situation in a: interruption of the AASV at its junction with the GSV, interruption of the branch feeding the GSV and of the distal GSV tributary. N1 ⊣ N2 → N3 – N1 ↘ N2 ⊣ N3 – … (**c**) Failure of the strategy with development of an apparently new reflux in the proximal GSV. (**d**) In the preoperative investigation, usually we find a diastolic flow from refluxing AASV into GSV, assuming the GSV at the proximal thigh is competent. (**e**) Manoeuver to discover the flow direction in the GSV at proximal thigh digitally closing the AASV during exploration. With permission by [10]

The treatment consists in a flush ligation of the AASV at the GSV in the groin and an interruption of the tributary feeding the GSV to diminish the flow into the GSV and flush ligation of the tributary distal at the GSV (Fig. 6.14b).

Very seldom the proximal GSV becomes incompetent after this strategy (Fig. 6.14c). Possibly it was already dilated but when measured with duplex, a reflux did not occur, because the amount of blood refluxing via AASV was more important, provoking an antegrade diastolic flow in the GSV (Fig. 6.14d). To unmask this latent reflux in the GSV prior to the first treatment step, the AASV has to be occluded (e.g. with a finger) during the ultrasound exploration, and then the GSV at proximal thigh has to be explored during a provocation manoeuver. Only if still there is no reflux in muscular diastole, the GSV at this level has to be assumed as competent (Fig. 6.14e).

6.5.2.6 Isolated Incompetence of the AASV

Sometimes we find an isolated reflux in the AASV with competent terminal and preterminal valves. The reflux source might be the competent GSV or a reflux from pelvine tributaries into AASV (see Fig. 6.15).

Classically and following CHIVA principles, an interruption of the AASV in the groin should be performed (half-coloured green interruption point in Fig. 6.15). As the amount of reflux is little (not emerging from the deep vein), the author generally treats these patients with foam sclerotherapy, if a treatment is really necessary (e.g. for cosmetic reasons). Alternatively, the interruption at fascial level with or without phlebectomy of the subcutaneous part of the vein may be performed (full-coloured green interruption point in Fig. 6.15). In theory, the AASV could be closed with endoluminal techniques.

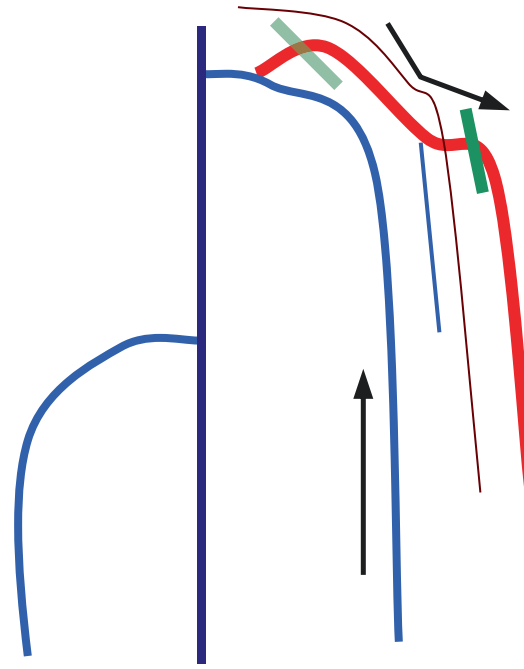

Fig. 6.15 Surgical procedure for isolated incompetence of the AASV. The brown tiny line represents the fascia. Either interruption of the AASV at the level of the GSV (surgically or with endoluminal devices) or after emerging the fascia in case of the existence of a competent distal AASV segment. Alternatively, the AASV without reflux from the deep veins can be treated with foam sclerotherapy. With permission by [10]

6.6 Management of Pelvic Reflux

Pelvic reflux has its origin in an incompetent pelvine network, filling tributaries at the groin, the ventral, inner or posterior part of the thigh and this finding a retrograde pathway to fill leg veins. The classification and treatment of the pelvic leak points are extensively discussed in Chap. 8.

The refluxing pathways originated by a pelvic reflux are:

- Pelvic reflux feeds the GSV via a tributary of the sapheno-femoral junction.
- Pelvic reflux feeds the GSV via a tributary at the thigh or the calf.
- Pelvic reflux feeds the SSV via a long tributary at the calf or the Giacomini vein.
- Pelvic reflux fills only tributaries, not involving a saphenous vein in the pathology.

The first situation is discussed in Sects. 6.6.1 and 6.6.2 and the last three in Sect. 6.6.3.

6.6.1 Competent Terminal and Incompetent Preterminal Valve

This condition is only known since the introduction of ultrasound to the diagnostics of superficial vein insufficiency. When applying saphenous vein ablative procedures, the source of the reflux is indifferent. It is always the same procedure: crossectomy and stripping. This is the reason why even after the introduction of ultrasound, the distinction of the source of reflux at the SFJ was not important for lots of phlebologists or vascular surgeons [16–18].

And this is the reason why often colleagues do not understand what is meant, when CHIVA appliers talk about competent terminal valve and incompetent preterminal valve or para-ostial reflux, referring to the fact that the reflux does not trespass the ostium, like the case described in Sect. 6.3.1, but comes from the tributaries in the groin (see Fig. 6.16).

This is why it is strongly recommended to gather further information in Sect. 4.4 and in additional books or articles, in case of not being familiar with the exploration of the groin tributaries. The terminal valve is competent; neither with dynamic provocation manoeuvres nor with Valsalva or compression release of the calf, a reflux from the femoral vein into the GSV can be generated. The reflux source is found in the supra-inguinal region, summarised as pelvic reflux (see Fig. 6.16a and Sects. 6.6, 6.11.4.2, and 6.11.4.4 and Chap. 8).

In these patients, no pathologic compartment jump is found at the level of the groin cease. But a pathologic amount of blood is drained into the GSV. The pelvic compartment ("P") feeds a tributary. This is the pathologic compartment jump. And this tributary meets the saphenous vein at the groin level (P → N3 – N2).

The drainage of groin tributaries into the saphenous vein is a physiologic condition. The amount of blood makes the difference (see Sect. 4.5). The origin of the reflux has to be found and possibly treated, depending on the drainage pathways (see shunt types 4 and 5 and Sects. 3.8.5, 3.8.7, 6.11.4, and Chap. 8).

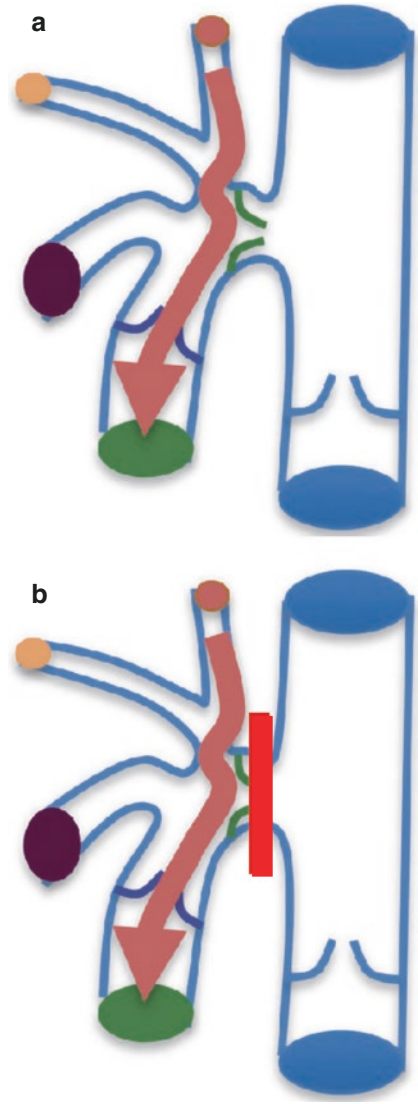

Fig. 6.16 (**a**) Para-ostial reflux that means competent terminal valve and incompetent preterminal valve. The reflux does not flow from the deep vein into the GSV. The origin is another network, in this case pelvic reflux. (**b**) Result after applying a crossotomy, an interruption of the GSV at the level of the ostium and leaving the reflux filling the GSV: The reflux situation is exactly the same as prior to the intervention (Compare Figs. 4.10–4.12 and 4.43). With permission by [15]

How to treat this condition? Thinking as usual in classical phlebology, as the GSV is refluxing starting at the SFJ, the "crosse" has to be treated. But when applying a crossotomy to a

para-ostial reflux and leaving the GSV in situ (we are doing saphenous vein sparing surgery!), this interruption would not change anything in the haemodynamic situation (see Fig. 6.16b, red line and Fig. 4.43).

In this condition and in the CHIVA context, a crossotomy is not an option.

The optimum would be to establish a drained situation, where either the reflux would be abolished at its origin (at the level of the pelvic network, see Chap. 8) or the reflux from the pelvic network would be drained into the deep veins in a proper way creating a stable drained circuit without a compartment jump in the leg that would cause a volume increase in any venous network of the leg.

Depending on the drainage situation of the GSV, different possibilities would be at choice:

If there is a draining perforating vein on the GSV (shunt type 4; see Fig. 6.17a) and a refluxing tributary at the leg, the tributary at the leg can be treated (see Fig. 6.17b), leaving the pelvic reflux drained through the GSV and the perforating vein. The GSV would suffer a discreet overload with pelvic blood, but often this situation remains stable throughout many years. If the amount of pelvic reflux is too high, the pelvic leak point should be treated (see Fig. 6.17c and Chap. 8).

Experimentally some colleagues have interrupted the GSV distally to the junction that means at the level of the preterminal valve. In classic venous surgery, this always has been thought to be malpractice leading to recidives. These procedures are only anecdotes, as the colleagues never published their results. Having a close look at the endoluminal thermal ablation therapies, the closure distally to the preterminal valve leaves exactly the same situation: the groin tributaries drain into the deep veins via the SFJ. Possibly in the future this could be an option as alternative to the surgical interruption of pelvic leak points, which is not a familiar routine method for every vascular surgeon (see Fig. 6.17d) [14].

If there is no draining perforating vein on the GSV (shunt type 5; see Fig. 6.18a), the interruption of the distal tributary will lead to a competent GSV in 97% of cases, stable throughout the time (see Fig. 6.18b) [13].

This is one of the optimum situations to apply CHIVA: A GSV with reflux and feeding refluxing tributaries is reverted to a competent vein, stable throughout time. The benefit for the patient is obvious: preservation of the complete untouched N2 system and no scar in the groin (neither surgical nor endothermal). And it is the optimal "starter" setting for hesitating colleagues: The flow reversion in a refluxing GSV is a strong "convincer".

To discriminate between the presence or not of a draining perforating vein along the refluxing GSV, the RET (reflux elimination test) is performed (see Sect. 3.8.9 and Fig. 3.31).

6.6.2 Incompetent Terminal and Preterminal Valve with Additional Reflux in Groin Tributaries

Sometimes, in addition to a reflux from the femoral vein into the GSV via an incompetent terminal and preterminal valve, an additional pelvic reflux joining in through a groin tributary is found. For this situation, as seen in Sect. 6.5.1, CHIVA proposes the crossotomy. The problem is that this would leave a reflux from the groin tributary into the GSV (as depicted in Fig. 6.16b).

There are some options:

- The pathologic tributary is interrupted in the context of the crossotomy. This would leave a non-drained situation for the pelvic reflux (groin tributary), which could lead to recidives fed by the pelvic leak point.
- The crossotomy is performed in addition to an interruption of the pelvic leak point (see Chap. 8).

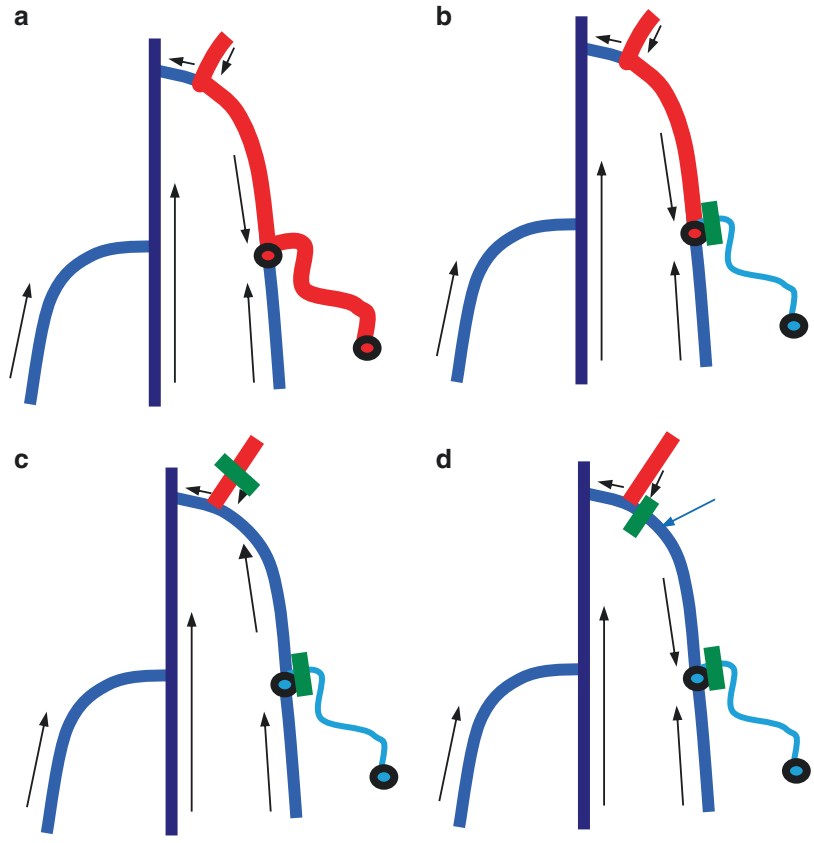

Fig. 6.17 (**a**) Shunt type 4 with pelvic reflux, filling the GSV retrogradely, draining through a perforating vein on the GSV and in a tributary. The terminal valve is competent and the preterminal valve incompetent. P → N2 – N1, N3 – N1 (**b**) One option is the interruption of the tributary. The tributary will reduce its calibre; otherwise it could undergo phlebectomy or sclerotherapy. The pelvic reflux will still fill the GSV and drain through the perforating vein. P → N2 – N1, N3 – N1 (**c**) If the volume overload in the GSV is too high, the pelvic leak point could be interrupted. As a result, the GSV would become competent. P ⊣ N2 – N1, N3 – N1 (**d**) Another option would be the closure of the proximal GSV distal to the preterminal valve with endoluminal thermal ablation of a short segment (e.g. 7 cm) in addition to the tributary interruption. This leaves the junction as drainage for the pelvic reflux, avoiding a reflux into the GSV. This option has the disadvantage that it disrupts the GSV instead of leaving it with antegrade flow as shown in c, and it leaves it with a retrograde flow filled by draining tributaries. P → N2 ⊣ N2 – N1, N3 – N1. With permission by [10]

- In case of a perforating vein draining the GSV, the pelvic leak point is left without treatment when performing a crossotomy, expecting a good drainage retrogradely through the GSV and the perforating vein, achieving a drained situation for the pelvic leakage.

6.6.3 Pelvic System Feeding Tributaries

A pelvic reflux feeds a tributary. The tributary is enlarged and can be seen through the skin at the inner thigh, ventral thigh or dorsal aspect of the

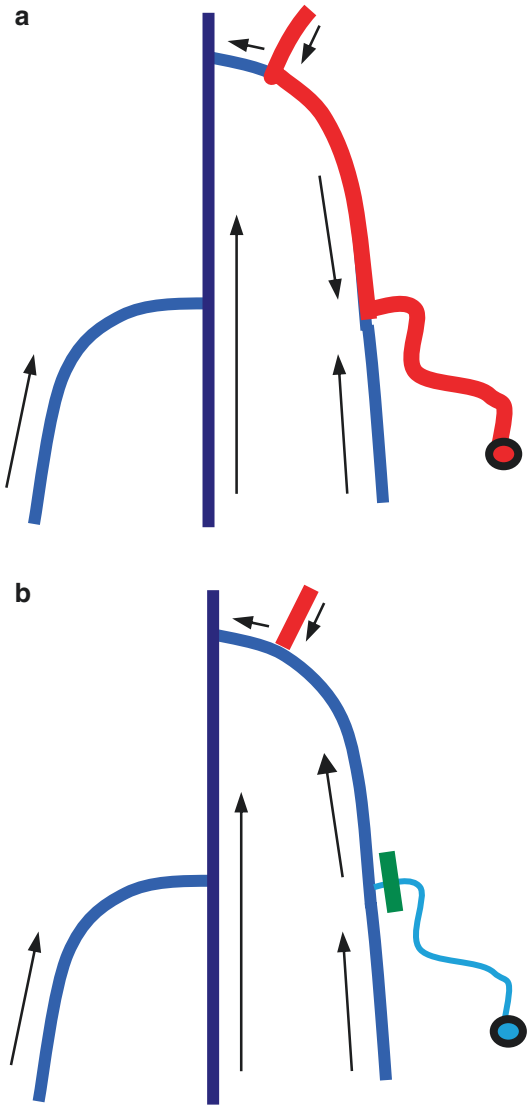

Fig. 6.18 (**a**) Shunt type 5 with pelvic reflux, filling the GSV retrogradely, draining through a tributary fed by the GSV. There is no dilated, draining perforating vein connecting the GSV with the deep veins. The terminal valve is competent and the preterminal valve incompetent. P → N2 → N3 – N1 (**b**) Treatment: interruption or phlebectomy of the tributary with the result of a stable flow inversion in the GSV in 97% of cases. P → N2 ⊣ N3 – N1. With permission by [10]

thigh. These tributaries can either meet an accessory or saphenous vein or be drained into a perforating vein.

Depending on the reflux amount, a surgical interruption of the pelvic leakage point is advised (see Chap. 8), or in case of lesser diameters, a sclerotherapy should be considered. Sometimes the sclerotherapy of the tributary will reverse the reflux in the affected saphenous or accessory veins.

6.7 Management of Incompetent Sapheno-Popliteal Junction

The considerations about reflux sources, treatment depending on the distal drainage explained for the GSV, also apply to the small saphenous vein (SSV). Still there are some differences. In the SSV, we do not find a terminal and preterminal valve, neither a complex tributary system. The pelvic reflux can feed the SSV via the Giacomini vein or a superficial tributary; this is however a very seldom condition that should be treated in the same way as explained for the GSV. In this chapter, only the special features of the SSV regarding to its anatomical and functional criteria will be exposed.

6.7.1 Anatomic Features of SSV

The small saphenous vein (SSV) shows only one tributary, the Giacomini vein or thigh extension of the SSV present in 60% of cases. The Giacomini vein begins at the SPJ and courses up the back of the leg to the mid-thigh and then turns medial and ventral to meet the GSV. It carries blood from the back of the thigh to the SPJ and/or the GSV; the direction of flow under physiological conditions has not been clearly established.

The SSV drains into the popliteal vein at different levels, in the knee-fold or above it, seldom below it via a muscle vein (see Sect. 4.6). These anatomic variations of the sapheno-popliteal junction (SPJ) have to be taken into account when deciding the treatment modalities in the CHIVA context.

Figure 6.19 shows the different anatomical elements of the SPJ (see also Sect. 4.6). A particularity of this junction, as compared to the SFJ, is that both the SSV itself and its "junction tributary", the vein of Giacomini, are covered by a very thick

fascia. This means that the SSV, the muscle veins and the vein of Giacomini are all directly subject to the same pressure as the popliteal vein.

6.7.2 Treatment of the SPJ Depending on the Giacomini Vein and Muscle Veins

The treatment of the SPJ depends on the anatomy. This has to be considered when planning the CHIVA strategy for the following reasons:

- Muscle veins from the gastrocnemius musculature drain directly into the SPJ and can have connections with the last 5–10 cm of the SSV. Thus, they may maintain recirculation after the SPJ has been interrupted as shown in Fig. 6.20a.
- Another source of permanent reflux can be found in the Giacomini vein, which can have connections to the deep venous system at the back of the thigh or even being refluxing fed by the GSV (see Fig. 6.20b).
- The vein of Giacomini may also present an excessively high blood column even without pathological reflux from the muscle veins, preventing a good cosmetic outcome after interruption of the SPJ leaving the Giacomini vein draining into the distal SSV (see Fig. 6.20b).

In the presence of reflux from the popliteal vein into the SSV, with no confluence of the vein of

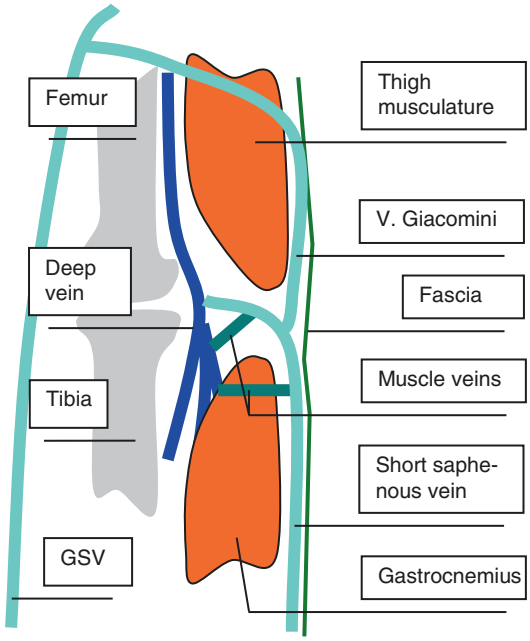

Fig. 6.19 Anatomic components of the junction of the small saphenous vein with the popliteal vein. Bones are represented in grey and muscles in orange. The deep venous system (N1) is in dark blue, muscle veins in turquoise and interfascial veins (N2) in light blue. The superficial fascia is very strong in the dorsal part of the leg, covering the N2—veins and the muscles, as well as the fossa poplitea like a tent. It is represented in green. The muscle-fascia wraps the muscles and is represented as black line covering the orange muscle (compare Fig. 4.25). With permission by [10]

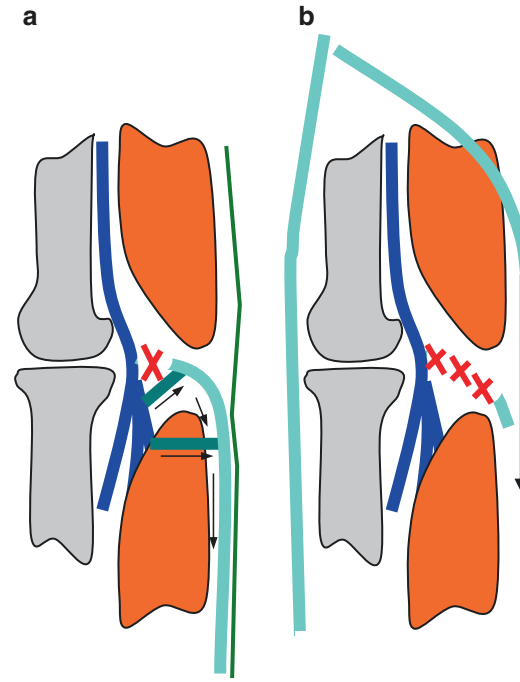

Fig. 6.20 Persistent reflux in post-operative examination after interruption of the junction of the SSV directly at the level of the popliteal vein. (**a**) Reflux persists through the muscle veins which wasn't identified prior to the intervention. (**b**) Persistent reflux through a long segment of the vein of Giacomini after interruption of the SPJ without treatment of the Giacomini vein. With permission by [10]

Giacomini or the muscle veins into the SSV, a classic flush ligation of the SSV at the confluence with the popliteal vein is recommended (no figure).

However, if the vein of Giacomini or muscle veins also flow into the SSV, examination a few weeks after interruption at the deep vein might show that the SSV is still filled refluxingly out of one of these sources (Fig. 6.20). That is the reason why in these cases it is best to interrupt the SSV distal to the vein of Giacomini as a first option, considering the SPJ as a perforating vein that is "terminalised" (see Sect. 6.9.2) with this strategy (see Fig. 6.21a) or distal to the muscle veins (see Fig. 6.21b red cross). Alternatively, the centimetres of SSV with confluence of muscle veins may be completely extracted, performing flush ligation at the popliteal vein and interrupting the muscle veins at the point they join in the SSV (see Fig. 6.21c, red lines and Fig. 6.22 for further details).

In case the SSV drains directly into a muscle vein and not into the SPJ, which is very often, the

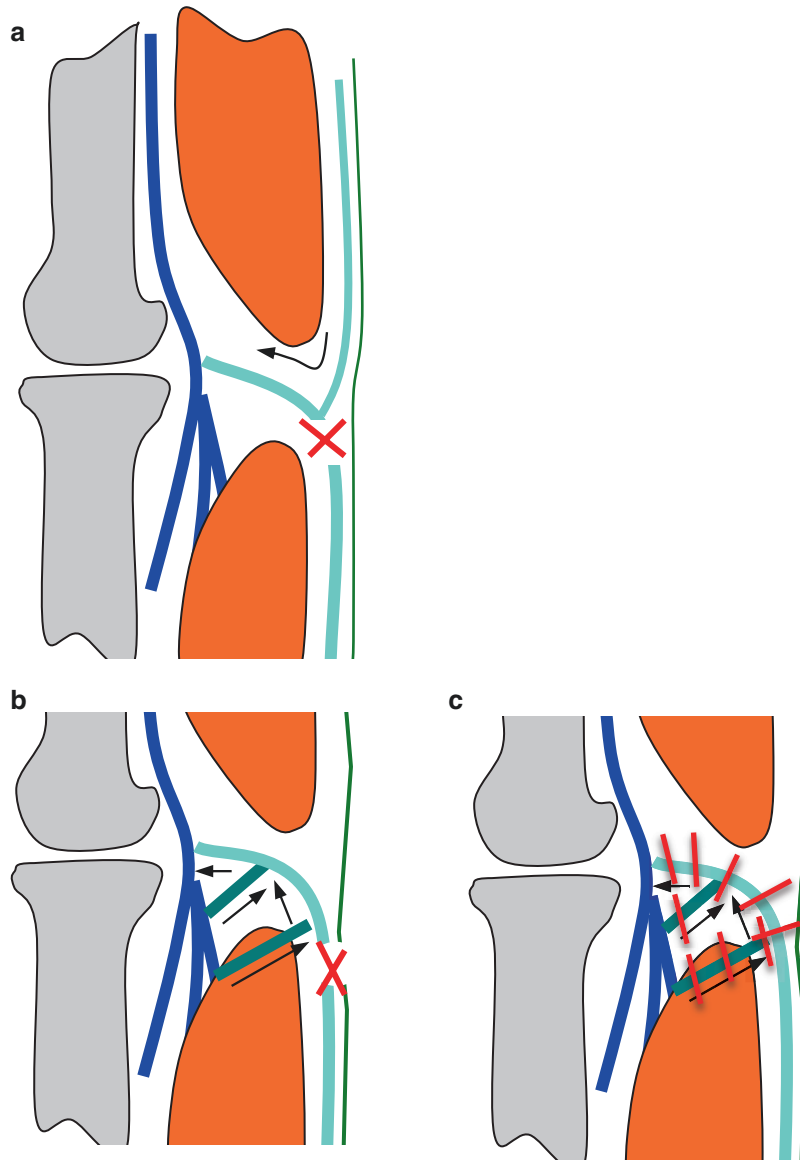

Fig. 6.21 Flow situation after interruption of the SSV not at the junction with the popliteal vein but (**a**) after interruption of the SSV below the vein of Giacomini confluence, allowing the blood of the Giacomini vein to drain into the deep vein through the junction, (**b**) after interruption of the SSV below the last muscle vein (red x) or (**c**) exhairesis of the junction (red lines). With permission by [10]

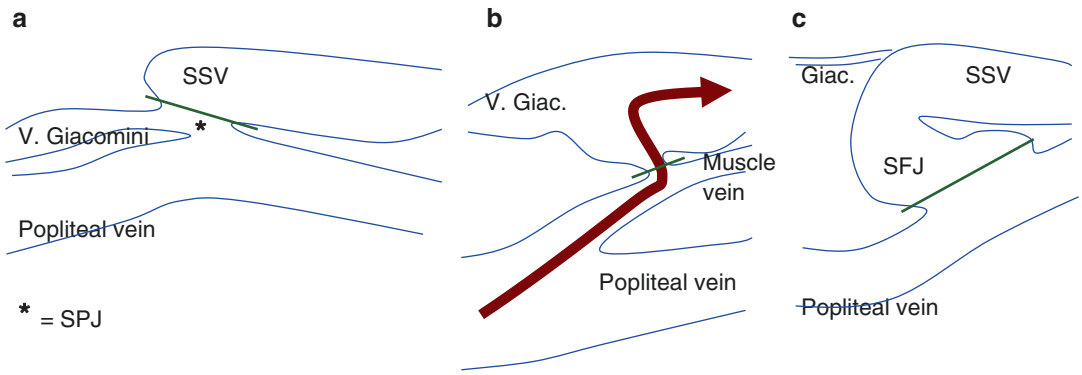

Fig. 6.22 (**a**) The vein of Giacomini drains directly into the popliteal vein. Interruption of the SSV is further distal, green line to allow drainage of the Giacomini vein. (**b**) (Corresponds to Fig. 4.27b) Reflux from the popliteal vein via a muscle vein into the SSV (red arrow). Treatment: interruption of the SSV at its confluence with the muscle vein (green line). (**c**) (Corresponds to Fig. 4.26a): Reflux from the popliteal vein into the very dilated SSV. Interruption of the SSV with flush ligation directly at the popliteal vein (green line). The thin vein of Giacomini will not bring a clinical relevant reflux into the SSV, so it may be left as perfusion of the SSV to avoid thrombosis. With permission by [10]

interruption level should be between the SSV and the muscle vein, not at the level of the popliteal vein, as then a deep vein (muscle vein) would be interrupted (See Fig. 6.22b).

6.7.3 Recurrences at the Sapheno-popliteal Junction

Unfortunately, recurrence after ligation distal to the junction may sometimes occur through a tributary in the popliteal fossa region (see Fig. 6.23): After interruption of the SSV below the confluence of the vein of Giacomini or the muscle veins, refluxing tributaries may appear in the popliteal fossa despite initial flow reversal, especially in case of mixed shunts with systolic reflux in the short saphenous vein. The blood flows from the SPJ into the subcutaneous vessels either directly from the SPJ or through the distal section of the Giacomini vein. The strategy may be sclerotherapy or interruption of the tributary. Before performing a flush ligation of the SSV at the level of the popliteal vein, it has to be sorted out that the Giacomini vein is not part of an open bypassing shunt replacing the function of the deep vein (see Fig. 6.45) in case of strong reflux.

In rare cases, in the absence of any connection between the SSV and the deep venous system in the fossa poplitea, the Giacomini vein takes over as the only vessel carrying drainage from the SSV. If the SSV is refluxing in these patients, the reflux usually originates from the GSV or a perforating vein at the back of the thigh. In the first case, the reflux in the GSV has to be treated. In the latter, the perforating vein should be interrupted (see Sect. 6.9.1).

Another specific problem of the SSV is very seldom found in the post-operative development years after the interruption of the SSV either next to the deep vein or distal to the confluence with the Giacomini vein. The SSV occasionally suffers a recanalisation or new anastomosis in the saphenous compartment, despite resection of some centimetres and use of non-absorbable suture. In ultrasound, a vessel like the SSV is seen at a place, where the first post-operative control demonstrated a correct interruption. Histology of the vein shows no muscle cells in the wall demonstrating a neovessel (author's own experience, not published). It almost seems as if the fascial sheath leads as guidance for the reconstruction of a vessel. To avoid this, it may be necessary in addition to sew the two fasciae (muscle and saphenous) together to close this virtual space.

All these difficulties must be considered when planning a strategy for the SPJ. The problem of

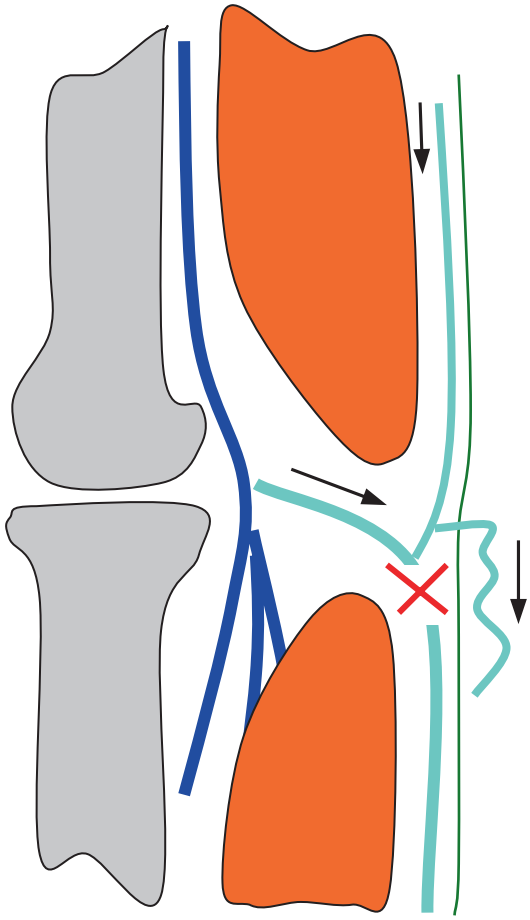

Fig. 6.23 Possible recurrence from the proximal V. Giacomini after distal interruption of the SSV. With permission by [10]

surgical treatment of the SSV using the CHIVA method is not finally solved however, as this condition is rarer than a reflux in the GSV and no randomised studies have been performed or published.

6.7.4 Alternatives to Surgery of the SPJ

Sometimes the surgical approach to the SPJ is not easy. The proximal centimetres of the SSV could then be closed with endoluminal applications (heat or glue) as an alternative. Another option to have in mind is to leave the SPJ untouched and to treat only the tributaries from the SSV. The SSV is covered by a strong fascia and reacts particularly well with calibre reduction after interruption of tributaries (see Sect. 6.4.1). Thus, even if muscle veins or thin perforating veins are present, the interruption of tributaries as only procedure should be considered. At the post-operative examination, the SSV might show antegrade flow or reduced reflux, draining into a perforating vein. This situation could be stable over years. If recurrent tributaries appear or clinics are still present, the SPJ must be treated in a second step.

If both saphenous veins are refluxing in the same patient, a connection often develops between them through a connecting tributary (transversal N4), either the Giacomini vein or a distal tributary. For management, see Sect. 6.11.6.

6.8 Management of Incompetent Saphenous Veins (N2)

The saphenous veins themselves are spared one of the most important targets of CHIVA. Thus, they are touched as little as possible. Depending on the situation, the proximal escape point filling the saphenous vein is interrupted (see Sect. 6.8.1), the escape point is interrupted (see Sect. 6.8.2) or the saphenous vein itself is interrupted (see Sect. 6.8.3).

6.8.1 Management of Incompetent Saphenous Veins Without any Interruption

In case of reflux along the saphenous vein without a draining perforating vein (RET positive), all the reflux of the saphenous vein will be drained into tributaries. An interruption of these refluxing tributaries N2 → N3 will be followed by antegrade flow (see Sect. 6.4.1.1) or volume reduction with the need of further steps (see Sects. 6.4.1.2–6.4.1.3 and 6.4.2).

Another situation, rarely found, is when the escape point is a perforating vein and not a junc-

tion (see Fig. 6.28c). In this case, the flow in the saphenous vein can be corrected without touching the saphenous vein itself.

6.8.2 Interruption of the Escape Point

The interruption of the sapheno-femoral or sapheno-popliteal junction is the most frequent treatment in case of refluxing saphenous vein and has been explained in Sects. 6.5 and 6.7.

A refluxing perforating vein feeding the saphenous vein is also to be interrupted—this would be an interruption of the escape point, but without touching the saphenous vein, and has been explained in Sect. 6.8.1.

6.8.3 Interruption of the Saphenous Vein Along Its Course

An interruption of the saphenous vein itself apart from its junction is seldom performed. The vein regenerates very successfully once the reflux is eliminated. This regeneration is surely supported by the saphenous fascia, as well as the large number of muscle cells in the vein wall. The cosmetic outcome is also better if the tributary is ligated at its confluence with the saphenous vein, instead of ligating the saphenous vein and leaving the tributaries to drain the reflux via a perforating vein.

The interruption of the saphenous trunk plays a role treating refluxes above and below the knee, especially in case of skin changes (see Sect. 6.3.4.2). The interruption can only be performed if there is a draining perforating vein along the refluxing GSV. Fractioning of the pressure column in the GSV will lessen the venous hypertension at the skin areas of the ankle leading to better regeneration after intervention.

Usually the interruption is best set below a knee perforating vein, where a large draining direct perforating vein is mostly found (Boyd or proximal paratibial perforating vein) (see Fig. 6.24). Note that in this case it is not the perforating vein that is interrupted but the GSV distal to the perforating vein. If the Boyd perforating vein would be interrupted instead, we would leave the long pressure column un-fractioned and take drainage possibilities away from the system, both counteracting the CHIVA strategy.

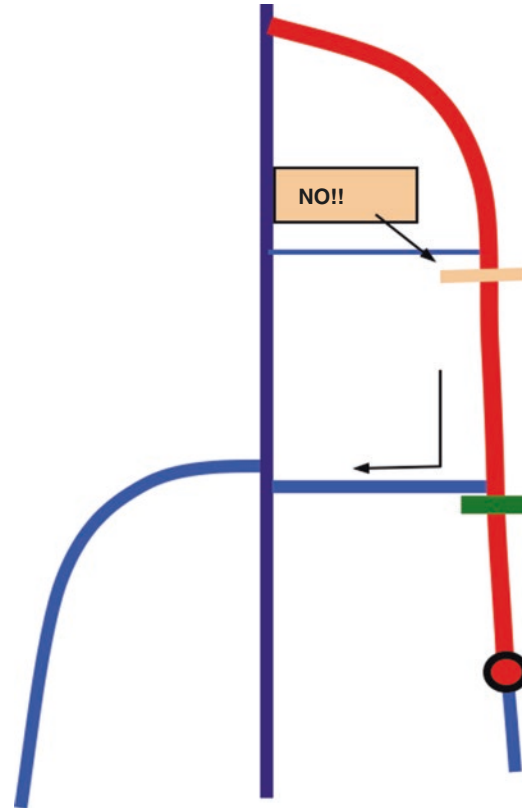

Fig. 6.24 Refluxive GSV with three perforating veins (blue lines along the refluxing segment of the GSV: thin line for thin perforating vein, thick line for large perforating vein and black circle as distal, draining or terminalising perforating vein). The first perforating vein, at the thigh, is too thin to drain the volume from the GSV. If the GSV was interrupted below this perforating vein (the position of the theoretical interruption is marked with an orange line), an undrained situation would be created in the proximal segment. The perforating vein below the knee has a large calibre (thick blue line). The GSV can be interrupted below it (green line) but only because distally to this point we find still a refluxing GSV and a third re-entry perforating vein (black circle), allowing the drainage of the GSV segment distal to the green ligation. With permission by [10]

This procedure is called "terminalising" a perforating vein: The vein was attached to a refluxing segment and now has become the end of the

reflux in this segment: it finishes the reflux conducting the blood from the proximal segment to the deep vein and thus "terminalises" the reflux.

6.9 Perforating Veins

The third pillar of the CHIVA strategy is maintaining re-entry points: These re-entry points are usually distended perforating veins, which carry the reflux back to the deep veins and so complete the circuit in the varicose veins. As explained in Sects. 3.5 and 4.7, it is rare to find a perforating vein as a reflux source. Mostly they are draining pathways along the refluxing vein segment or they are at the end of the refluxing vein.

As a rule, a perforating vein should not be interrupted if:

- It has a flow towards the deep vein in diastole: it is a draining perforating vein.
- It has a flow towards the superficial vein in systole: it is the beginning of an open bypassing shunt and is part of the drainage of the leg.

6.9.1 Perforating Veins as a Reflux Source

A perforating vein can be considered a reflux source, if it has a flow towards the superficial vein in diastole. Only these will be interrupted in CHIVA. The flow can be:

- N1 → N2 from the deep vein into a saphenous vein
- N1 → N3 from the deep vein into a tributary

The classical case of a refluxing perforating vein as reflux source for the saphenous vein (N1 → N2) is an incompetent perforating vein at the medial thigh feeding the GSV with refluxing (see Fig. 6.28c as an example). As a treatment, the interruption of the perforating vein is mostly recommended, though sometimes it is not necessary, if the diameter is not too large.

Another more frequent situation is an incompetent perforating vein at the back or lateral aspect of the thigh filling a tributary (N1 → N3). In this case, the treatment of the perforating vein can be surgical with phlebectomy of the tributary or both could be treated with sclerotherapy, depending on the diameter.

6.9.2 Perforating Veins Along the Refluxing Segment

Perforating veins along a refluxing segment usually serve as drainage paths. Blood flow is from superficial to deep. So, they play the role of a re-entry for the shunt (N3 – N1 or N2 – N1). If there are several perforating veins, one of them is the last one in the row, and the others are "intermediate", because there is reflux in the drained way above and below the perforating vein. In these "intermediate" perforating veins, it is possible to apply an interruption of the superficial vein (N2 or N3) **below** the perforating vein (see Fig. 6.24). This procedure is called "terminalisation". The perforating vein then is the end of the refluxing segment, draining the refluxing blood to the deep venous system thus interrupting the pressure column. Terminalisation refers to the fact that this perforating vein is converted from a perforating vein along the refluxing segment into the end of the refluxing segment.

For a perforating vein to be used as part of the CHIVA strategy, its calibre must always be sufficient to drain the refluxing blood, which flows from the superficial vein to the perforating vein (see Fig. 6.24).

Rule of Thumb: The diameter of the perforating vein must be at least half that of the vein to be drained.

Examples:

1. Refluxive GSV, diameter 9 mm. Perforating vein of the adductor canal (formerly Dodd), diameter 2 mm: It cannot be considered as part of the strategy; therefore the GSV must not be

interrupted below this perforating vein (see Fig. 6.24 orange line).
2. Refluxive GSV, diameter 9 mm. Perforating vein below the knee, diameter 6 mm: The GSV can be interrupted distal to the perforating vein (see Fig. 6.24 green interruption).

If the lumen of the drainage route (here the perforating vein) does not bear the correct relation to the lumen of the vessel to be drained (here the proximal GSV), thrombosis may occur in the GSV as the consequence of an undrained situation.

The further distal the perforating vein is in the leg, the less likely it is to be a reflux source. If there is any doubt, decisions over the treatment of perforating veins should always be deferred to the post-operative examination. The patient often understands that the treatment is performed in two steps: First interruption of the primary reflux source and later, perhaps, a further interruption of a tributary or saphenous vein distal to a perforating vein, or an interruption of the perforating vein itself, if it has become refluxing.

This is sometimes the case when a refluxing SFJ and a large perforating vein in the adductor canal are found (see Fig. 6.25). In the first investigation, reflux from SFJ fills the GSV, the pressure columns of GSV and deep vein are competitive, and as in the femoral vein the valves are competent, we observe an inward flow through the perforating vein. After interruption of the SFJ, the pressure column in the superficial vein is reduced, and the flow through the perforating vein reverts and becomes clearly refluxing. In that case an interruption of the perforating vein in a second intervention is necessary.

Another aspect to take into consideration if we find several perforating veins along a tributary or a saphenous vein is the distance between them. If they are at a long distance with a large pressure column, the interruption below the "intermediate" perforating vein is a good option (see Fig. 6.26a). If they are close together and the

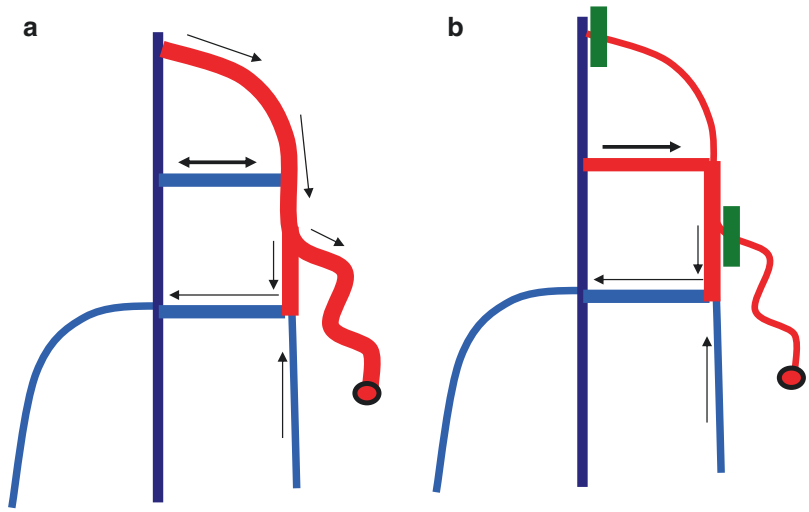

Fig. 6.25 (**a**) Reflux N1 → N2 at the SFJ with in and outflow over a proximal thigh perforating vein. Drainage from the GSV into the deep vein through a below knee perforating vein (N2 – N1) as well as through a tributary. (**b**) Treatment with crossotomy and tributary disconnection (green lines). The interruption of the thigh perforating vein deserves a large scar and so it is possible to wait and see the behaviour after some months. In this case, the flow has become obviously outward, filling the GSV and draining through the below knee perforating vein; thus the proximal now refluxing perforating vein can be disconnected in a second step (not shown). With permission by [10]

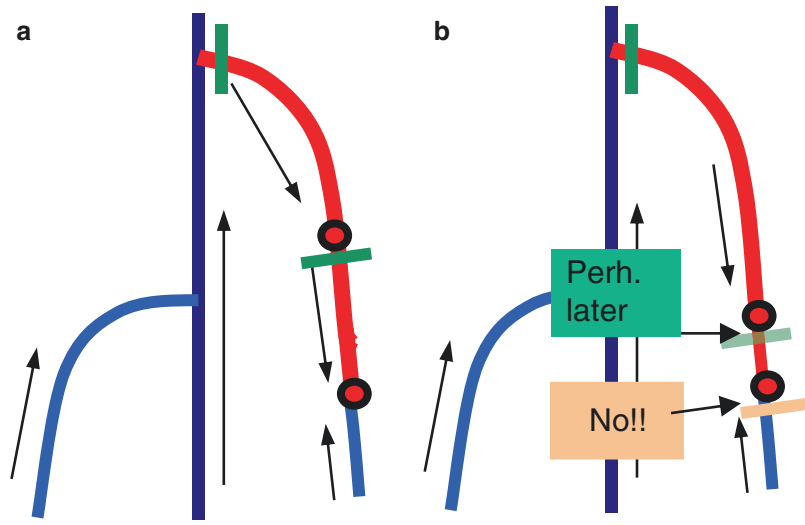

Fig. 6.26 (**a**) Recirculation N1 → N2 – N1 with two well-separated draining perforating veins. The treatment is the interruption at the SFJ (green line), and it can be added by an interruption below the proximal perforating vein (green line). (**b**) Recirculation N1 → N2 – N1 with two draining perforating veins that are close together: interruption at the SFJ only (green line). Just in case the skin should be severely damaged and does not recover properly after the SFJ interruption, the interruption below the proximal perforating vein will improve the situation (light green line). Cave: Never interrupt below the lowest draining perforating vein (orange line); otherwise the distal antegrade draining GSV will lose its drainage, which also is through this perforating vein. These explanations apply also to perforating veins along refluxing tributaries. With permission by [10]

distance between the "intermediate" perforating vein and the last draining perforating vein is very short, the interruption is not worth the scar, because we are just leaving a very short segment—this would only make sense, if we are dealing with an ulceration or severe skin changes—and then only in a second step situation, after skin has partially recovered in consequence of the interruption of the primary reflux source (see Fig. 6.26b). These explanations are true for N2 and N3 vessels drained by perforating veins.

6.9.3 Perforating Veins at the End of the Refluxing Segment

Most of the time at the end of a shunt, we find a perforating vein, draining either a refluxing saphenous vein or a tributary. This one should never be interrupted. It is the drainage of the reflux, and most often it is also the drainage of the distal vessel, which is not affected by the recirculation, especially in case of a GSV reflux (see Fig. 6.26b).

6.10 Management of Tributaries

Tributaries are all the superficial veins running in the subcutaneous tissue. When they become incompetent, they get enlarged and meandering. Physiologically they play the role of the superficial venous reservoir which seems to trigger a progression of varicose disease in case of dilated veins. Tributaries are the mediators of the pathological volume overload and provoke skin changes and proliferate to cope with the pressure (see Sects. 2.2.2 and 2.5). And they are responsible for the cosmetic complaints. In case of little disease, the treatment of tributaries can restore the flow in the saphenous veins (shunt type 5, Sect. 6.4.1.1 and ASVAL, Chap. 12).

If only tributaries (N3) are refluxing, without N2 reflux, the disease is little. We find this in the following situations:

- N2 → N3 – N2/N1 (no reflux from the deep vein): The treatment is the interruption or sclerotherapy of the tributary until the junction with the saphenous vein (see Sect. 6.11.2).
- N1 → N3 – N1: The tributary is fed by a perforating vein, which has to be interrupted. Most often this can be done with a foam sclerotherapy, alternatively with a surgical interruption (see Sects. 6.9.1 and 6.11.5).

6.10.1 Management of N2 – N3 Jump in Case of Positive RET

The reflux elimination test "RET" was designed to examine the drainage paths of the refluxing saphenous vein. It is described in Sect. 3.8.9. In case the RET is positive, this means that on the saphenous vein, there is no draining perforating vein. Interrupting the N2 → N3 jump will be the final treatment, if the terminal valve is competent, resulting in 97% of competent GSV after 3 years. In case of incompetent terminal valve, GSV competence will still be achieved in 29% of cases [13]. As described in Sect. 6.4, the further evolution can be challenging, for the surgeon and for the patient's patience.

6.10.2 Management of N2 – N3 Jump in Case of Negative RET

A negative RET tells us that on the saphenous vein filling the tributary, we find other draining paths—this can be a perforating vein or another tributary or both.

In case of a draining perforating vein, we can interrupt the junction and all the present refluxing tributaries, knowing that the saphenous vein will be drained. This is the optimum situation for a long-lasting, stable CHIVA result.

6.10.3 Management of Refluxing Tributaries Along Their Course (N3)

The treatment of tributaries is often the most important step from the point of view of the patient. The fourth column of CHIVA explicitly includes tributary exhairesis in case of poor drainage. The combination of CHIVA 1 or 2 in the saphenous trunk with simultaneous phlebectomy of all the tributaries offers the possibility of proceeding to achieve quick cosmetic results whilst preserving the saphenous vein.

Tributaries may be removed, but this is not inevitable. With tributaries, it is true to a certain extent that the thicker the vein, the more likely it is to regenerate. But if the diameter is clearly greater than 1 cm, or the tributary has already presented thrombosis, there is a greater probability of poor venous retraction or thrombosis developing after the intervention.

A more important criterion for the removal of tributaries is the flow that they carry. If the retrograde flow is fast and of short duration, which means that they are well-drained, they will in all probability regenerate quickly and without thrombosis. If the retrograde flow is long-lasting and the curve relatively flat, the vein is poorly drained and may be removed.

After performing CHIVA with the main focus on the saphenous veins, the tributaries may reduce their calibre making no more treatment necessary because they have disappeared to the rough eye observation or because the patient has no high cosmetic demands. This is especially true for large recirculation volumes with distal skin changes in elderly patients. Sometimes it is obvious that the tributaries meander through long segments and have lots of divisions, or run specially near under the skin, which makes a calibre reduction leading to a macroscopic disappearance improbable. In these cases, interruption has

always to be considered at a point where tributaries branch.

The following possibilities of interruption at branching points exist:

- Same calibre of vessels, both courses of equal length: The tributary causing the bigger cosmetic problem is interrupted.
- Same calibre of vessels, courses of different lengths: One branch soon runs into a perforating vein, the other after a longer distance—interruption of the longer branch (see Fig. 6.27, green line). This keeps the pressure column as short as possible.
- Unequal calibre, but the thinner vessel is still able to drain the proximal section if the other tributary is closed by compression in ultrasound (see Fig. 6.2): interruption of the larger vessel.
- Unequal calibre: The thinner vessel is not sufficient to drain the larger—ligation of the smaller vessel, if any.

It may be said that tributaries can always be interrupted below a branch point or perforating vein, so long as the calibre of the branch or perforating vein is sufficient to drain the reflux coming from proximal on its own (see examples on Fig. 6.27). And the decision to treat tributaries can always be postposed to the control visit, as often then less tributaries will be treated than planned in the first session.

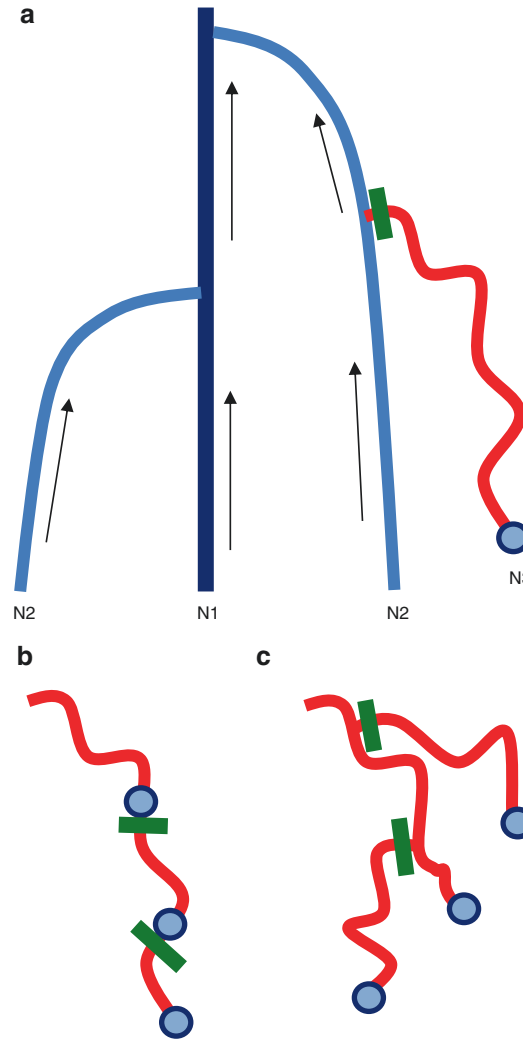

Fig. 6.27 (**a**) Refluxive N3 tributary filled by competent GSV: no branching, no perforating veins apart from the last one (black circle). The interruption will be made at the level of the junction between the tributary and the GSV (green line). No possible interruption along the tributary. (**b**) Same situation than in (**a**), only the tributary is shown. There are three perforating veins along the tributary, and so the tributary can be interrupted below both tributaries on its course, as shown. The last tributary is the re-entry for the last segment. No interruption has to be performed here. Please note that the interruption will be performed on the tributary, not on the perforating vein. (**c**) Branching with different length of segments: interruption of the longer tributary to achieve the best cosmetic result. The interruption has to be performed next to the branching point, without leaving blind sacks to avoid thrombosis. With permission by [10]

6.11 Management According to the Shunt Type

6.11.1 Shunt Type 1

Remember: N1 → N2 – N1 (Fig. 6.3 left and Fig. 6.28)

Recirculation from the deep vein (N1) into the great or small saphenous vein (N2). A distended perforating vein carries the recirculation volume directly out of the affected saphenous vein into the deep vein system (black circle on the vein).

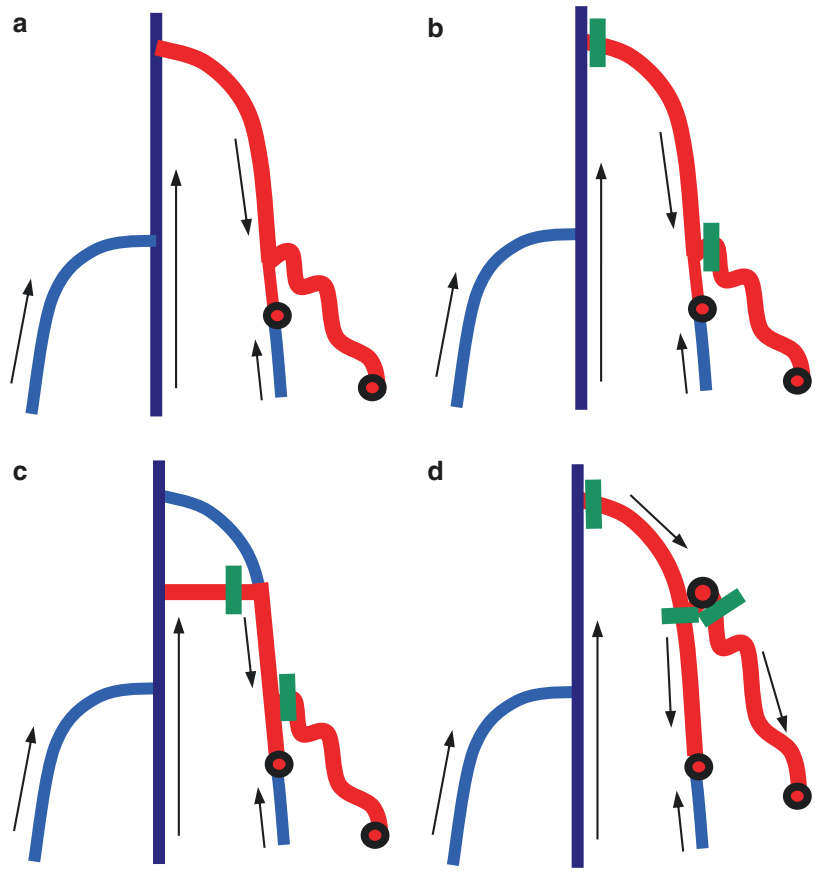

Fig. 6.28 (**a**) Shunt type 1 with tributary or shunt type 1 + 2. (**b**) Interruption of the tributary and the junction in presence of a well-draining perforating vein. (**c**) Competent SFJ, reflux into the GSV through a thigh perforating vein (N1 − N2) with drainage through a perforating vein at the GSV below the knee and through a refluxing tributary. Interruption of the perforating vein and the tributary: Attention the GSV is not interrupted!! (**d**) Refluxive GSV with refluxing tributary. There is a good perforating vein on the tributary just after its confluence with the saphenous trunk. Interrupt at the green lines if a reduction in the pressure column in the distal GSV is to be achieved. With permission by [10]

The principal recirculation runs: Deep–Saphenous–Deep, with no intermediate tributary. One or more tributaries may be involved in the recirculation. Then, this shunt type is also called type 1 + 2 (see Fig. 6.28a).

The strategic decision will depend on where the reflux source is and how many re-entry points there are. The following possibilities exist, **depending on the reflux source**:

- **Highest reflux source is the sapheno-femoral or sapheno-popliteal junction**:
  Always treat the saphenous junction (see Fig. 6.28b)
- **Highest reflux source is a perforating vein**:
- Interruption of the perforating vein (which is very seldom in CHIVA, as a perforating vein is very seldom the reflux source!) (see Fig. 6.28c)

The following possibilities exist, **depending on the re-entry points**:

- **One perforating vein and no tributaries**
  Interruption of the highest reflux source only
- **Several perforating veins and no tributary**
  Interruption of the highest reflux source and the refluxing saphenous vein below the perfo-

rating vein (see Figs. 6.24 and 6.26 and Sect. 6.9.2). The saphenous trunk must never be interrupted below the most distal perforating vein, as this eliminates the drainage from the healthy distal saphenous vein (see Fig. 6.26b orange line). There are no haemodynamic benefits for the GSV in dividing the pressure column by creating short segments.

- **One perforating vein and one or several tributaries**
  If the perforating vein presents with a large calibre, the highest reflux source and all the incompetent tributaries are interrupted close to the saphenous vein. If the calibre of the perforating vein is not very large but is draining the saphenous vein, the situation may be treated as a shunt type 3: in other words, applying CHIVA 2. First only the tributaries will be interrupted with flush ligation at the saphenous vein. At the post-operative examination, the junction will still be refluxing and the saphenous vein calibre lessened. The perforating vein will have adapted its calibre to cope with the remaining reflux from the junction. The second step of CHIVA 2 will then be the interruption of the junction.
  Alternatively, the SFJ can be interrupted, leaving one tributary untreated so that it serves to drain the saphenous vein in addition to the perforating vein. If it is found in the post-operative examination that the calibre of the saphenous vein has diminished, then the last incompetent tributary can be treated. In this situation (thin calibre perforating vein), a second operation is very often needed also in shunt type 1, regardless of what treatment is used, if a superficial thrombosis shall be avoided.
- **Several perforating veins and several tributaries**
  This may be assumed as a situation with good drainage of the saphenous vein as there is more than one perforating vein on the saphenous vein. The junction and all tributaries can be interrupted, and if appropriate, the saphenous vein can be disconnected below a perforating vein to fractionate the pressure column.
- **Perforating vein on a tributary close to the saphenous trunk**
- This condition often occurs at the thigh. Treat the SFJ and other tributaries as usual. In case of dilated perforating vein on the tributary (see Fig. 6.28d): interruption of the saphenous vein below the confluence with the tributary (which then drains the blood from the saphenous trunk into the very short segment of the tributary and then into the perforating vein) and interruption of the tributary distal of the perforating vein. Afterwards the proximal saphenous vein is drained through the perforating vein situated on the tributary. Neither the tributary nor the distal saphenous vein is connected any more to the proximal reflux source. In case no fractioning of the pressure column of the GSV is wished, the tributary is disconnected at the saphenous vein and the perforating vein is interrupted, to avoid feeding of the distal tributary (no image).

6.11.2 Shunt Type 2

Remember: N2 → N3 – N2/1

Recirculation from a (healthy) saphenous vein into a refluxing tributary (see Fig. 6.29).

The calibre of these refluxing tributaries is not very large, since the recirculation volume cannot be very great if no deep veins are involved. In shunt type 2, only blood from the superficial vein system can be part of the incompetence, by definition. As a rule, treatment by interruption of the highest reflux source is enough. That means interruption at the level of the confluence between tributary and saphenous vein. In some cases, additional interruptions need to be done at other branching points of the refluxing tributaries to other junctions (see Sect. 6.10.3).

Alternatively, an isolated mini-phlebectomy of the refluxing tributary (N3) can be performed. The saphenous trunk is not harmed, which is a principal object of CHIVA. A third option is the application of sclerotherapy to the tributary without any surgery in an attempt to abolish reflux.

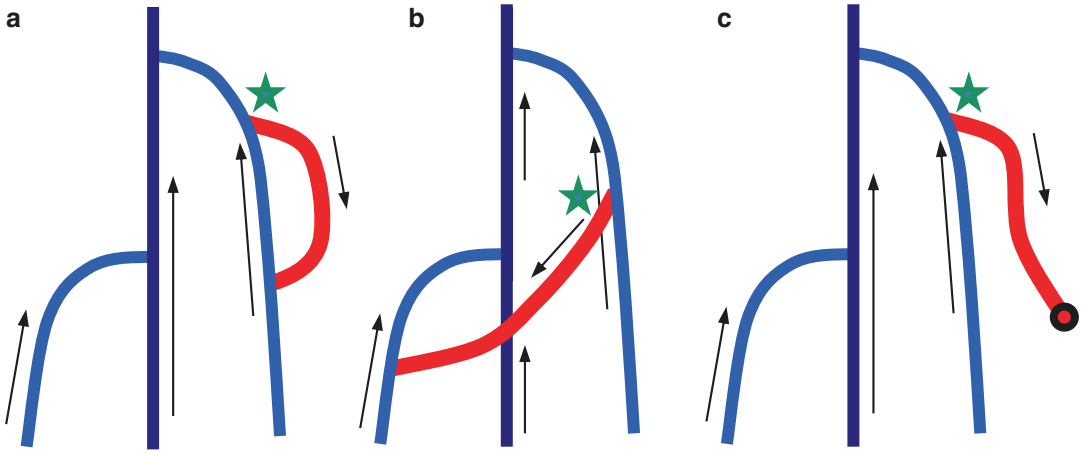

Fig. 6.29 Different forms of shunt type 2. (**a**) Closed shunt type 2 N2 → N3 (=N4L) – N2. Remember: N4 stands for N3 connecting two saphenous veins, in this case the same, thus "L" for longitudinal. (**b**) Open deviated shunt type 2: N2 → N3 (=N4T) – (different) N2. Remember: N4 means N3 connecting two saphenous veins, in this case different ones, thus "T" for transversal. (**c**) Open deviated shunt type 2: N2 → N3 – N1. All three cases would be treated with interruption at the reflux start (green star) (N2 ⊣ N3). With permission by [10]

This is the easiest option for sure. But it has the risk of damaging the saphenous trunk by foam propagation if not properly done (see Sect. 7.12).

6.11.3 Shunt Type 3

Remember: N1 → N2 → N3 – (N2) – N1.

Recirculation from the deep veins into one of the saphenous veins and then through one or more tributaries back into the deep vein system. There is no distended perforating vein on the saphenous vein which could act as drainage between the reflux source and the first competent segment of the GSV further down (see Fig. 6.30). This is the commonest form of recirculation together with the shunt type 1.

The highest reflux source is the junction or, very rarely, a perforating vein filling the saphenous vein directly. The treatment is described in detail in Sect. 6.4.1. The fact that it cannot be treated leaving a stable, drained situation in one session without devalvulation (see Sect. 6.4.2) makes this shunt the more complex to understand or deal with.

As with shunt type 1, this strategy depends on the source and re-entry point of the reflux.

6.11.3.1 Shunt Type 3 with the Highest Reflux Source in a Junction

During the preoperative duplex ultrasound, be sure to document the flow profile in PW in the saphenous vein and its diameter. Apply the first surgical step: interruption with flush ligation of all refluxing tributaries where they join the saphenous vein (first step of CHIVA 2).

Follow-up with duplex after at least 6 weeks:

- Proximal saphenous vein is competent: Follow-up in further 6–12 months
- Proximal saphenous vein with diminished reflux (PW record is less than preoperatively or reflux appears only in the Valsalva manoeuvre and not in dynamic provocation manoeuvers) and the patient has no cosmetic complaints: Tell the patient to come back in 6 months or earlier if varices reappear or in the event of distress. In case of progression, see next step.
- If the reflux is unchanged to the preoperative situation (which occurs if a perforating vein opens, or a new tributary or bypass round the ligation forms), the junction must be treated.

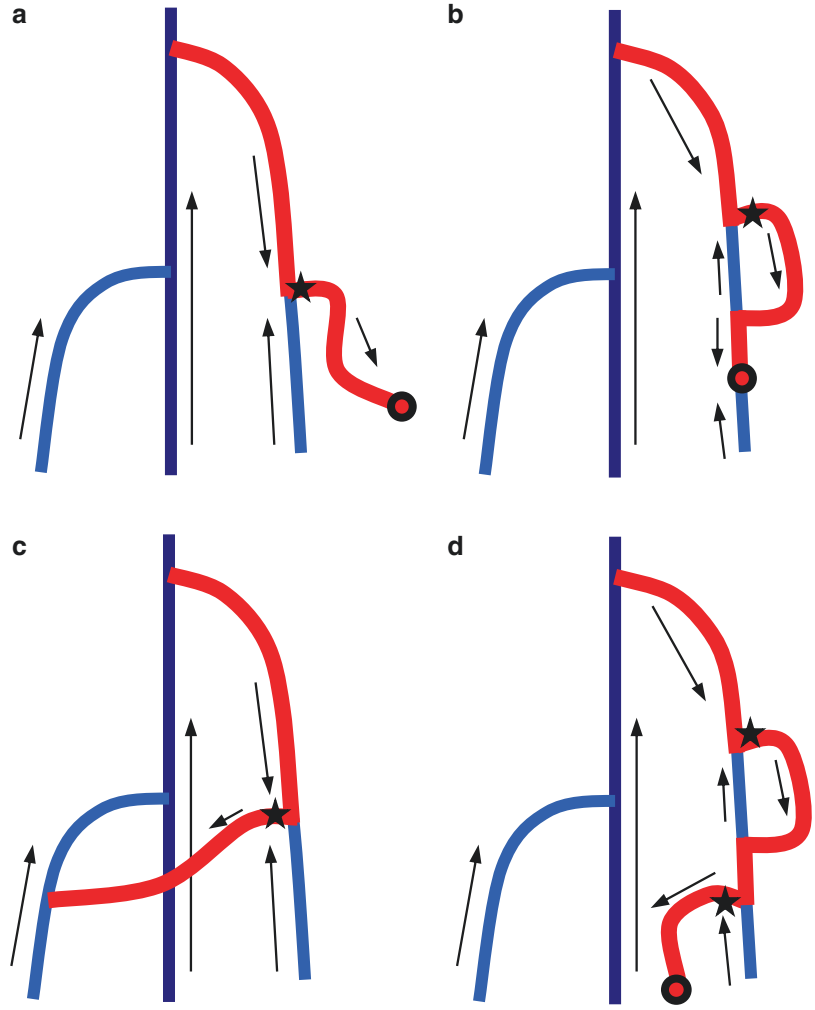

Fig. 6.30 Shunt type 3 with different draining pathways. The black star marks the point, where the first step of CHIVA 2 would be performed, the so-called CHIVA 2 Point. (**a**) Shunt type 3: N1 → N2 → N3 – N1. (**b**) Shunt type 3: N1 → N2 → N3 (=N4 L) – N2 – N1. (**c**) Shunt type 3: N1 → N2 → N3 (=N4 T) – N2 – N1. (**d**) Shunt type 3: N1 → N2 → N3 (=N4 L) – N2 → N3 – N1 (N4 L means N3 connecting the same saphenous vein, longitudinally; N4 T means N3 connecting different saphenous veins, transversally). With permission by [10]

6.11.3.2 Shunt Type 3 with the Highest Reflux Source Is a Perforating Vein

This is a rare condition, mainly through a perforating vein at the thigh. Usual procedure at shunt type 3.

- In case of little reflux and small perforating vein: flush ligation of the CHIVA 2 point only and control of perforating vein at follow-up. Only if there is still a reflux in the perforating vein and a new tributary has developed, perform the interruption of the perforating vein in the second step.
- In case of large reflux amounts and dilated perforating vein, perform flush ligation of the tributary and interruption of the perforating vein in the first session, but never touch the GSV itself.

6.11.3.3 Management in Case of Aplastic Segments of GSV

Sometimes the GSV itself has aplastic segments with a superficial accessory longitudinal vein acting as a bypass (see Sect. 4.5.1). In case of reflux and in the absence of a functional interfascial saphenous trunk, this accessory vein may be seen as a "functional saphenous vein" (Fig. 6.31), and a CHIVA 2 procedure may be applied. However, the regeneration rate after CHIVA 2 in the author's experience is not so good. Depending on the diameter of the proximal saphenous vein, an interruption at the junction in the first session may be the better option for dilated veins.

6.11.3.4 Management Depending on the Drainage Pathways

The "CHIVA 2 point" is always interrupted at the saphenous vein; only subsequent drainage variants are discussed here:

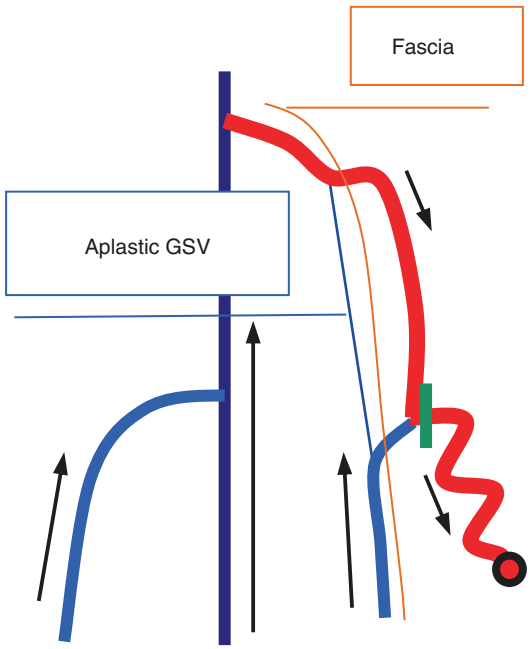

Fig. 6.31 Shunt type 3 with an aplastic segment of the GSV and bypass via a superficial rectilineous accessory vein, draining the reflux into a tributary. The distal GSV is competent, no drainage through a perforating vein from the GSV itself. Interruption at the origin of the tributary leaving the rectilineous bypass of the GSV is a treatment option. With permission by [10]

- **Drainage through a** tributary with re-entry into a perforating vein: Interruption at the CHIVA 2 point is sufficient (Fig. 6.32a).
- **Drainage through several tributaries (not shown)**: Every tributary must be interrupted at its junction with the saphenous vein.
- **Drainage through a tributary which drains back into the distal GSV**: The distal GSV is refluxing and drains into a perforating vein. The segment between both refluxing segments of GSV is competent. Interruption at the CHIVA 2 point is sufficient. After this interruption, the distal GSV should no longer be filled in retrograde flow, allowing it to regenerate (Fig. 6.32b).
- **Drainage as before, with a new draining tributary for the distal segment of GSV**: Both refluxing junctions with flow from the saphenous vein into the refluxing tributary are treated as CHIVA 2 points (see Fig. 6.32c).

The small saphenous vein (SSV) in the authors' experience reacts particularly well to the CHIVA 2 procedure (which is a different experience as compared to other groups). Unfortunately, no CHIVA 2 results on SSV are published so far.

6.11.3.5 Shunt Type 3 in Combination with Shunt Type 1

Sometimes a combination of shunt types 1 and 3 can be found in the same recirculation: in the upper part, we find a shunt type 1 with a perforating vein on the saphenous vein; but, below the perforating vein, the blood drainage corresponds to shunt type 3 (see Fig. 6.33). The saphenous vein is still refluxing distally to the perforating vein and drains then through a tributary. If a ligation of the GSV below the perforating vein is performed, as shunt type 1 procedure expects, the tributary is obliged to serve as drainage for the distal, antegrade section of the GSV. This will not produce a good cosmetic outcome. The upper section should therefore be treated as shunt type 1 with interruption of the SFJ. The section below the perforating vein should be treated as shunt type 3, using CHIVA 2: The tributary must be interrupted with a flush ligation at the GSV.

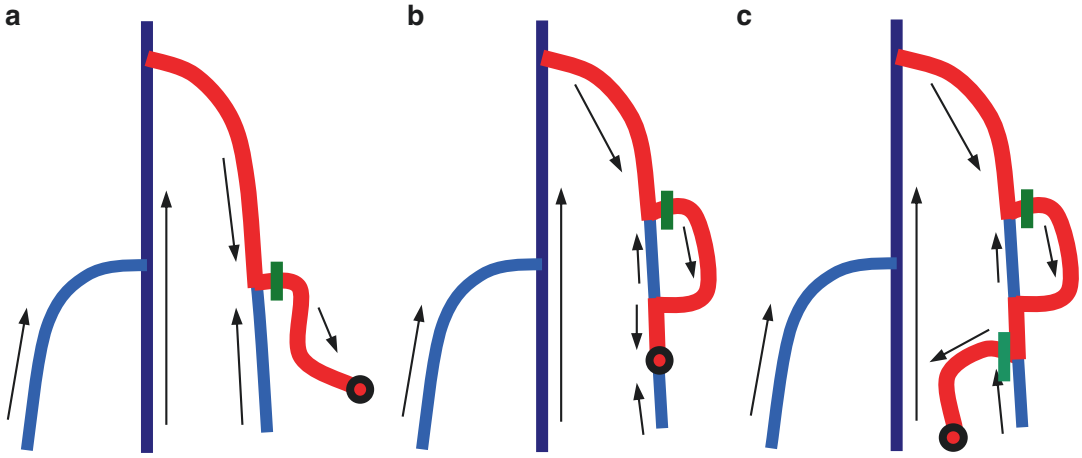

Fig. 6.32 Treatment options for the first step of CHIVA 2 in shunt type 3. (**a**) One draining tributary—interruption of the draining vessel at its junction with the saphenous vein. N1 → N2 ⊣ N3 – N1 (**b**) One draining tributary, which itself drains back to the distal GSV and there into a perforating vein. Treatment as **a**). N1 → N2 ⊣ N3 – N2 – N1 (**c**) One draining tributary, draining back into the distal GSV and there again into a draining tributary and a perforating vein. N1 → N2 ⊣ N3 – N2 ⊣ N3 – N1. With permission by [10]

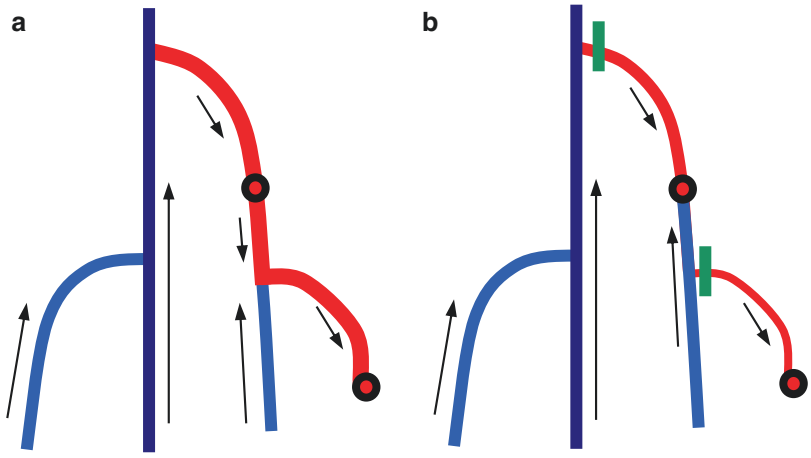

Fig. 6.33 (**a**) Shunt types 1 and 3: The proximal recirculation is a shunt type 1 with refluxing SFJ and draining perforating vein on the GSV (N1 → N2 – N1). The GSV continues to be refluxing downwards, draining through a tributary a perforating vein (N1 → N2 → N3 – N1). N1 → N2 – N1 ↘ N2 → N3 – N1 (**b**) The treatment option is the interruption of the junction and of the tributary; the flow in the distal GSV will get reverted and drain into the perforating vein. N1 ⊣ N2 – N1 ↘ N2 ⊣ N3 – N1. With permission by [10]

6.11.3.6 Examples of Shunt Type 3 Cases

As shunt type 3 and CHIVA 2 are the most revolutionary innovations to replace stripping, some examples are explained in the figure legends (Figs. 6.34, 6.35, 6.36, and 6.37).

A problem when starting with CHIVA 2 is that many doctors do not like to tell patients that they may have to return in some months for a junction operation, in other words, that they still may have the most serious part of the operation ahead of

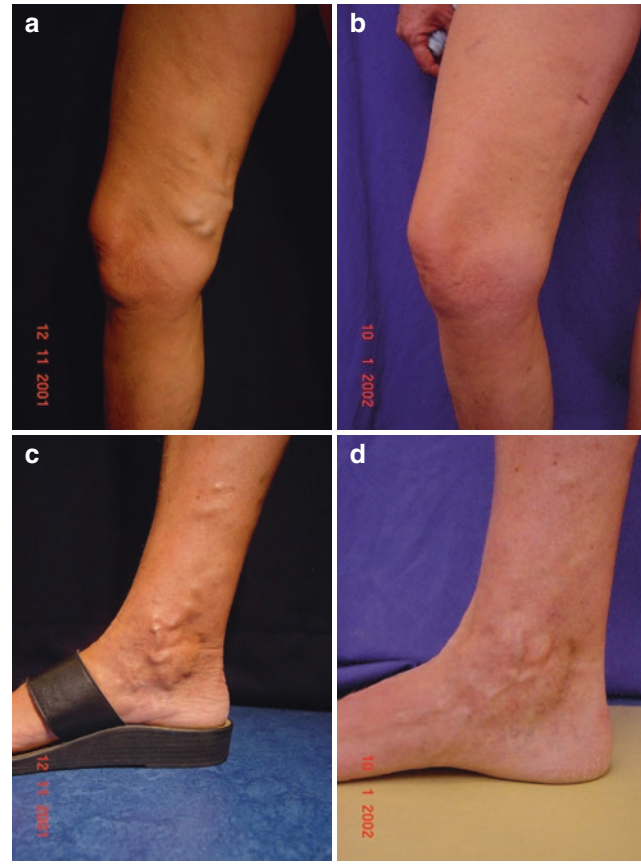

Fig. 6.34 (**a**) Top left (12.11.2001) preoperative photograph: shunt type 3 with flow pattern as in Fig. 6.32a. (**b**) Bottom left: Preoperative image of the foot. (**c**) Top right post-operative control (10.01.2002): After exposure of the GSV at the thigh with disconnection of the tributary as the only treatment. SFJ is competent in post-operative examination; tributary has reduced its calibre and is no longer visible. (**d**) Bottom right: Post-operative image of the foot. This post-operative situation was still stable at the follow-up 15 years later. With permission by [10]

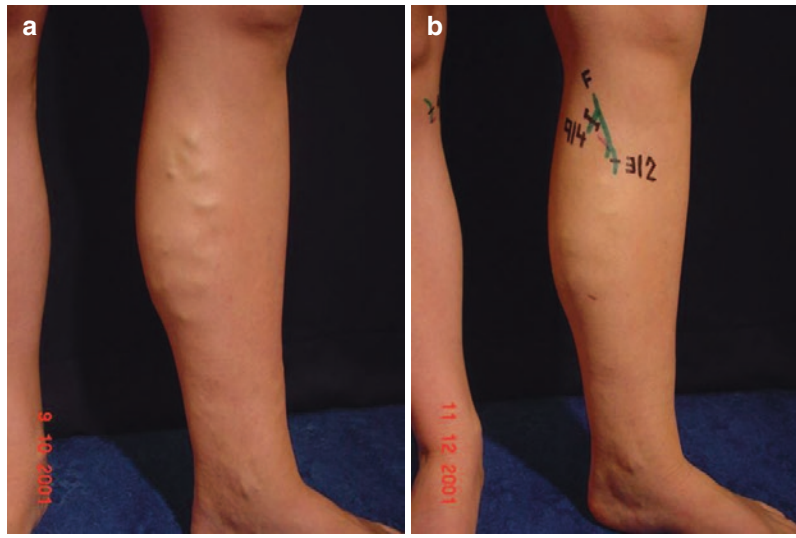

Fig. 6.35 (**a**) 02.10.2001: Preoperative photograph—shunt type 3 with flow pattern as in Fig. 6.32a. (**b**) 11.12.2001: Follow-up 9 weeks after exposure of the GSV in the calf (scar visible under the green line, above the mark 3/2) and ligation of a tributary further distal. Cosmetic result: less veins but still visible. Duplex result: The SFJ was (less) incompetent in the post-operative examination, with new reflux through tributary above the previous CHIVA 2 point. The patient wanted a second attempt with interruption of the new CHIVA 2 point and not an interruption of the junction, so we proceeded as drawn: Exposure of the newly formed CHIVA 2 point and interruption of another tributary. (Not shown: Finally, the SFJ had to be interrupted, because always new tributaries were formed). With permission by [10]

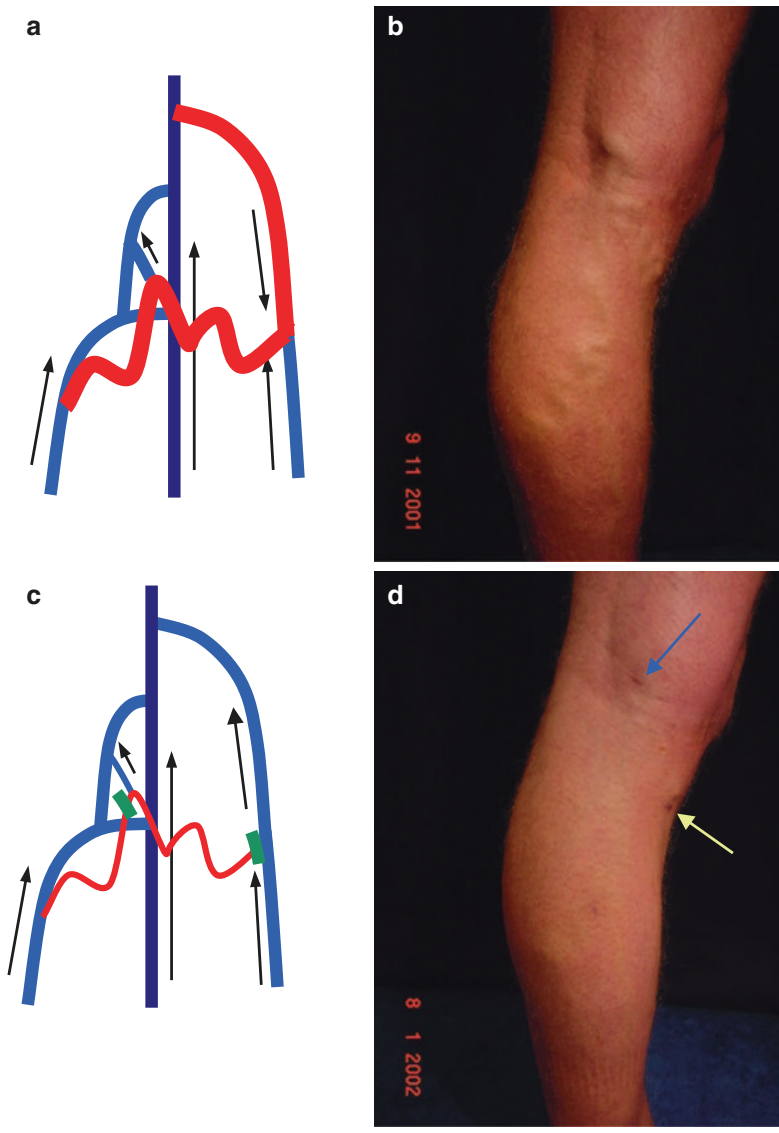

Fig. 6.36 (**a**) Shunt type 3 of the GSV with drainage of the tributary through a competent small saphenous vein and a connection to the competent thigh extension of the SSV. (**b**) 09.11.2001: Preoperative photograph. (**c**) Flow scheme after interruption of the tributary at the junction with the GSV and after branching and draining into the thigh extension of the SSV. Competent SFJ, calibre reduction in the tributary. (**d**) 08.01.2002 Photograph at control after flush ligation of the tributary (yellow arrow) and further interruption of the tributary above the knee crease (blue arrow) as the only measures. Cosmetic disappearance of the tributary without phlebectomy. With permission by [10]

them and that in the meantime there may be no cosmetic improvement.

In Germany, where the doctor is payed per procedure, the dissociated technique (CHIVA 2 with two steps) was not a problem at all. If the patient is properly informed that he is going to have a very little surgery, touching only a tributary, which might resolve the problem with his saphenous vein in approximately 30% of cases, normally the patient will accept the idea. It is most often not a problem of the patient but of the surgeon, who is used to "resolve" things in one session.

A consensus of 21 CHIVA-applying doctors in Germany found out that, in case of shunt type 3 with reflux in GSV ending above-knee, all of them performed the first step of CHIVA 2, because it is highly probable to have a stable anterograde flow situation, and this is just the most important achievement of the technique to allow a refluxing GSV to revert to antegrade flow again [19].

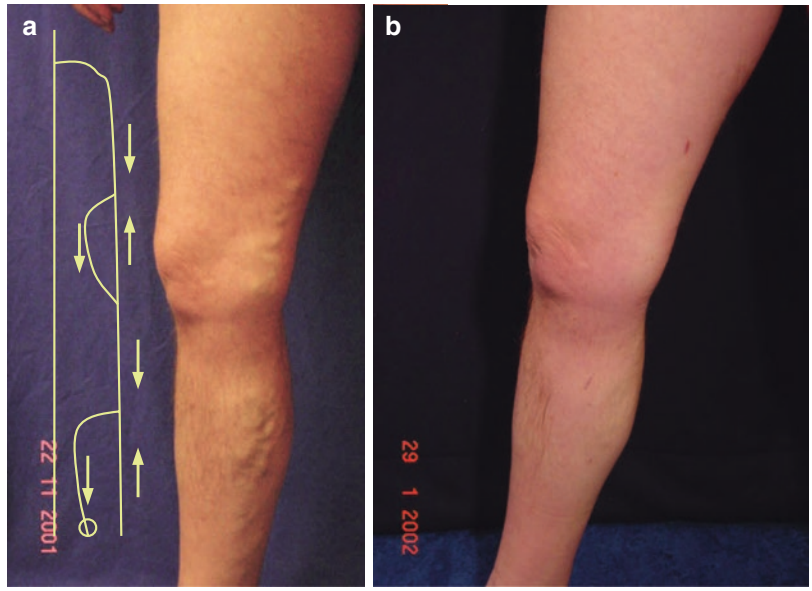

Fig. 6.37 (**a**) 22.11.2001 Preoperative photograph: shunt type 3 with flow pattern as in Fig. 6.32c, which is also shown on the left border of the picture. (**b**) 29.01.2002: Follow-up after exposure of the GSV in the thigh and lower leg with disconnection of the tributaries as the only measures. The SFJ is competent in post-operative examination. With permission by [10]

6.11.4 Shunt Types 4 and 5

As the strategy in case of shunts 4 and 5 have some common points, they will be described together.

Shunt type 4:
Remember: Pelvine shunt type 4: P → N3 – N2 – N1
Perforating vein shunt type 4: N1 → N3 – N2 – N1

Recirculation in the saphenous vein with origin not directly from the deep venous system, but through a tributary, which may conduct reflux from pelvine vessels (Pelvine shunt type 4) or from perforating veins (perforating vein shunt type 4). Drainage directly from the saphenous vein to the deep vein via perforating vein analogous to drainage in shunt type 1 (Fig. 6.38).

Shunt type 5:
Remember: Pelvine shunt type 4: P → N3 – N2 → **N3** – N1
Perforating vein shunt type 4:
N1 → N3 – N2 → **N3** – N1

Recirculation in the saphenous vein with origin as shunt type 5. Drainage from the saphenous vein to the deep vein via a tributary. No dilated perforating vein on the saphenous vein, analogous to drainage in shunt type 3.

Variations of these shunt types are described in Chap. 3 (Fig. 6.39).

Following the CHIVA methodology, the correct procedure would be to interrupt the **reflux source**. In case of a perforating vein reflux, this is easy to perform by interruption of the perforating vein (shunts 4 and 5); see Sect. 6.9.1.

In case of pelvic reflux, the reflux source will never be touched within the leg. Even an interruption of the pelvic tributary in the groin with phlebectomy as far as you may go through the groin incision will not reach the proximal reflux point.

Franceschi and Bahnini first described the interruption at the P point (perineal reflux) and the I point (inguinal reflux) which was later elaborated by Delfratre, described in Chap. 8.

If the pelvic reflux source shows as a net of tributaries emerging from the labia or visible at the inner part of the proximal thigh or a long epigastric vein visible on the skin proximal to the inguinal ligament, then it might be enough to treat this net with sclerotherapy to reduce the proximal reflux in the same session as the distal tributary interruption.

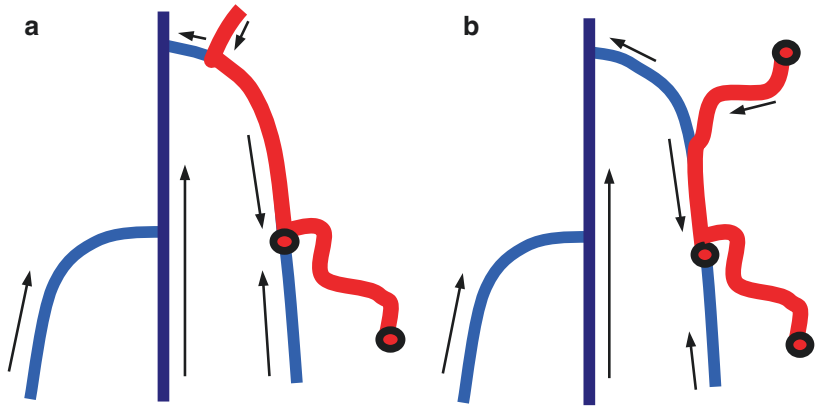

Fig. 6.38 Shunt type 4 is defined by the drainage from the GSV through a perforating vein on the GSV (mandatory). Additionally, there can be a drainage through a tributary. (**a**) Pelvic shunt type 4. (**b**) Perforating vein shunt type 4. With permission by [10]

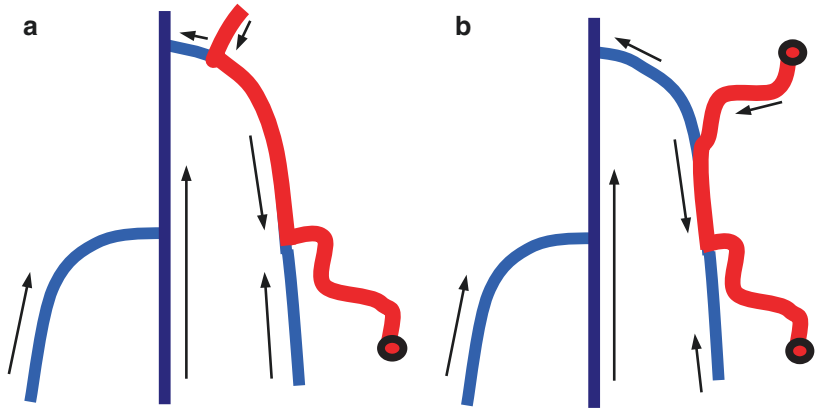

Fig. 6.39 Shunt type 5: It is defined by no draining perforating vein on the GSV. Reflux drains via a tributary. (**a**) Pelvic shunt type 5. (**b**) Perforating vein shunt type 5. With permission by [10]

In case the sclerotherapy is not feasible and no surgeon with experience in interrupting pelvic leakage points is available, this supra-inguinal reflux will be always a source of recidives, independently of the technique applied. In the eyes of the author, the treatment of the GSV distal to the confluence of the refluxing pelvic branches with endoluminal thermal ablation of some centimetres may be one option and is being investigated. It would allow a drainage of the pelvic reflux to the deep veins through the junction, perhaps avoiding the natural evolution to new varicose veins in the groin or via inner, dorsal or ventral aspect of the thigh.

Sometimes not treating the junction in case of little reflux drained via a perforating vein (shunt type 4; see Fig. 6.17b) is an option: The little reflux might take years to develop, whilst the recidives after interruption often develop to bothering tributaries on the proximal thigh after some months. In any case, the patient must be informed that the highest reflux source is pelvic and will not be treated in this case.

Treatment of tributaries: In both cases (shunt types 4 and 5), the tributaries will always be disconnected from the saphenous veins as described for shunt types 1 and 3, respectively.

6.11.4.1 Perforating Vein Shunt Type 4

(a) *No distal tributaries present* (Fig. 6.40a): Interruption of the refluxing perforating vein

(b) *Tributaries present* (Fig. 6.40b): Interruption of the refluxing perforating vein and distal tributaries. The refluxive tributaries can be interrupted in any case and independently of the drainage capacity of the draining saphenous vein perforator, because saphenous vein can also be drained through its untouched and antegrade junction.

6.11.4.2 Pelvic Shunt Type 4

(a) *No distal tributaries present* (see Fig. 6.41a): Prior to any treatment, it has to be considered, if a treatment is necessary. This is a typical case of a "stable" reflux. It exists, but normally it does not harm the patient (no cosmetic complaints because no tributaries are visible, normally no pain as the reflux amount is not too large). If a decision to treat the vein was made, interruption of the pelvic reflux must be performed (sclerotherapy, interruption of leakage point, closure of the GSV distal to the preterminal valve with endoluminal heat).

(b) *Distal tributaries present* (see Fig. 6.41b): In case of *little amount of reflux*, perform interruption of the tributaries to meet cosmetic exigencies. If reflux in saphenous vein is little (e.g. diameter of saphenous vein at proximal thigh less than 4–6 mm), an interruption of the tributary might be enough to achieve a stable situation without touching the proximal source. The result after interruption only of the tributary in Fig. 6.41b will be shown in Fig. 6.41a (prior to treating the pelvine reflux). With little reflux, this situation can keep stable over years. In case of *large amounts of reflux*, an interruption of the pelvic reflux with all its variant forms and their limitations as described above will be necessary, as well as the interruption of the tributary.

6.11.4.3 Perforating Vein Shunt Type 5

In this situation, the treatment is very easy: interruption of the refluxing perforating vein and interruption of the refluxing tributary or tributaries with flush ligation (see Fig. 6.42).

6.11.4.4 Pelvic Shunt Type 5

This is the perfect situation to apply CHIVA 2 tactic.

First step: Interruption of the refluxing tributary (Fig. 6.43a). In case of subfascial net of pelvic tributaries emerging from the labia or visible at the medial aspect of the proximal thigh (see above), a sclerotherapy of these tributaries

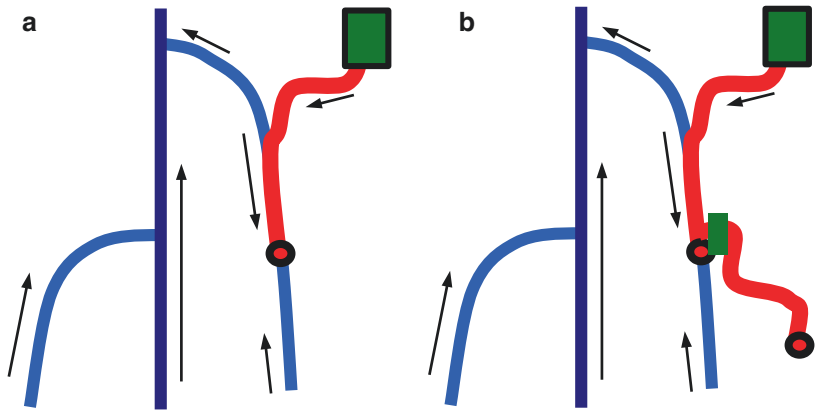

Fig. 6.40 Shunt type 4 perforating vein without tributary (**a**) and with tributary (**b**). The perforating vein has to be treated with subfascial closure (green rectangle), the tributary only if present. With permission by [10]

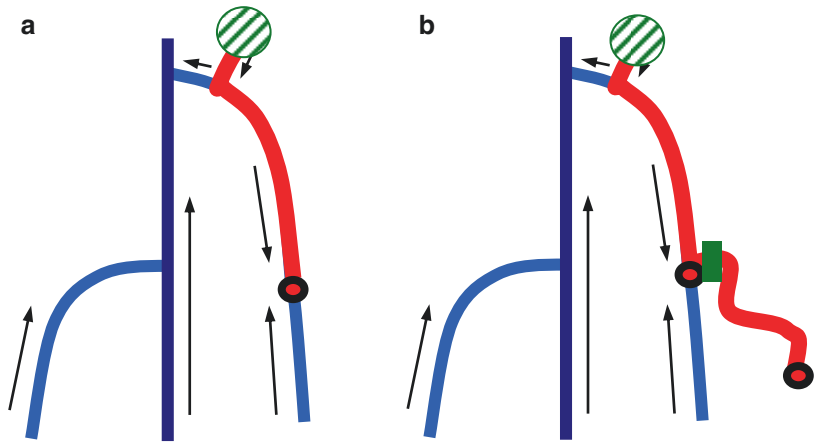

Fig. 6.41 Shunt type 4 with pelvine reflux without additional refluxing tributary (**a**) and with additional refluxive tributary (**b**). (**a**) Consider not to treat anything or deal with the pelvine reflux (see text), represented with a green and white lined circle. (**b**) Consider interrupting only the connection between tributary and GSV (green line) and treat the pelvine reflux (green and white lined circle) only if clinics make this step necessary due to large amounts of reflux. With permission by [10]

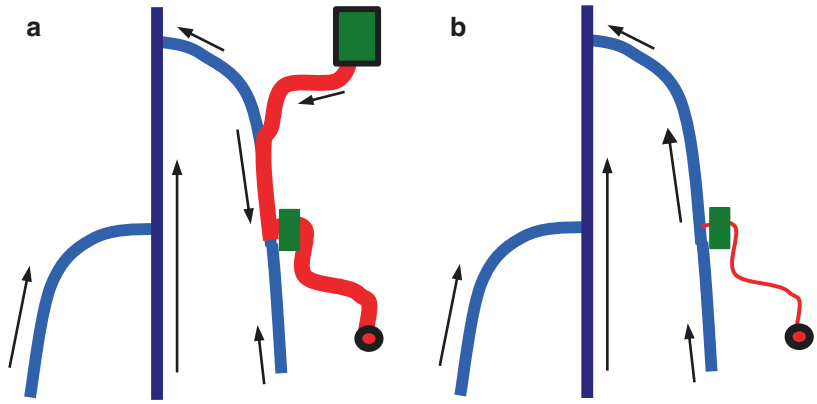

Fig. 6.42 Shunt type 5 perforating vein: (**a**) Interruption of the perforating vein (green rectangle) and the tributary. (**b**) In almost all cases, antegrade flow in GSV. With permission by [10]

may be done in the same session with the tributary disconnection.

Second step: Follow-up after 8 weeks to some months with two possibilities:

- *In 97% of cases, saphenous vein has no reflux* (see Fig. 6.43b):
  Refluxive pelvic tributary drains through the junction to the deep vein. No need of further interruption. Follow-up after 6 and 12 months just to make sure the saphenous vein does not develop a new reflux fed by the pelvic tributary.
- *Saphenous vein has reflux* (3%; see Sects. 6.4.1.2–6.4.1.3). Reflux in saphenous trunk after tributary disconnection is only possible, if a new draining point has opened. There are two options:
  – Drainage through a new refluxing tributary proximal or distal from the interruption point. We find again a pelvic shunt type 5. The tributary could be disconnected again. However, our experience teaches that in almost all the situations, the reflux from the groin will

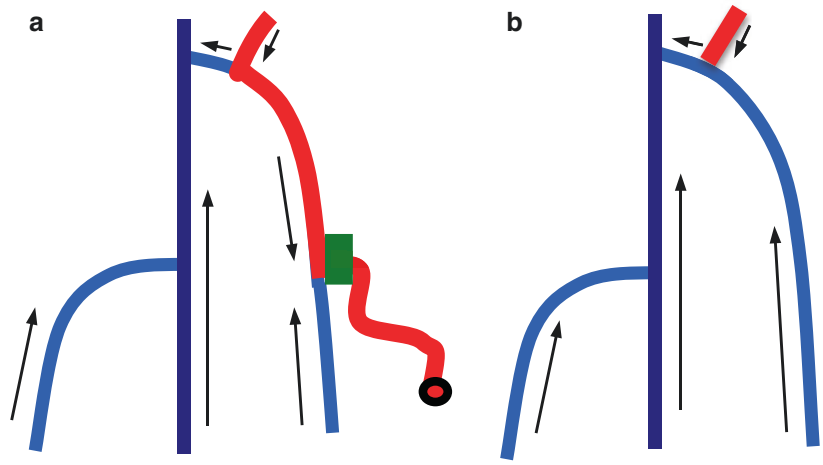

Fig. 6.43 Pelvic shunt type 5: (**a**) First step disconnection of the tributary (green line). (**b**) Result in 97% of cases: Pelvic reflux is drained via the competent terminal valve into the deep vein; GSV is competent. With permission by [10]

reappear, so it is the best to treat the pelvic reflux with one of the options as described above.

– Drainage through a perforating vein on the saphenous vein. In this case we have a pelvic shunt type 4. Further treatment is described there.

6.11.5 Shunt Type 6

Remember: This is a conglomeration of all reflux situations not covered by shunt types 1–5. The saphenous vein is not involved in the recirculation. It is mostly the situation with a reflux emerging from perforating veins or pelvic reflux that feed tributaries without saphenous vein involvement in the reflux.

The treatment depends on the extension of the disease. Often the cosmetic bothering veins are so tiny that a sclerotherapy is sufficient, even to treat the refluxing perforating vein.

Following the CHIVA principles, the reflux source should be interrupted: disconnection of the perforating vein or interruption of the pelvic leak point. The visible tributaries at the leg may be left in situ waiting if they reduce after interruption of the reflux source. If the cosmetics are the principal reason for the patient to ask for a treatment, the tributaries may be treated by sclerotherapy, phlebectomy or interruptions at branching points.

6.11.6 Shunt Involving Both Saphenous Veins

Sometimes patients present with reflux in both saphenous veins of one leg. Mostly these refluxes are interconnected. It is very seldom to find independent refluxes affecting both superficial collectors. In this case, they have to be treated isolately considering each as one recirculation circuit.

Often, especially in persons after sports with trauma on the calf, different muscle perforating veins with reflux feeding superficial N3 vessels independently are found. This is another situation with lots of independent recirculations, but not affecting saphenous veins.

The two scenarios most often found is the connection of great and small saphenous vein either through the Giacomini vein or through a tributary below the knee. In both situations, either vein can serve as drainage for the other.

6.11.6.1 Connection via the Giacomini Vein

Reflux starting at the sapheno-popliteal junction (SPJ) can feed the Giacomini vein and then the great saphenous vein (GSV) as shown in

Fig. 6.44. This is not too rare. The shunt is interesting from different points of view:

- It is the combination of an open and a closed shunt.
- It can be composed by a systolic and a diastolic shunt (see Fig. 3.31, Sect. 3.9.1).
- Concerning the closed shunt, the re-entry is further down in the leg than the escape point, but the path runs much higher in the leg than the reflux source.

With the upcoming of duplex investigation, lot of early recidives after stripping of GSV were identified as caused by Giacomini vein reflux. Thus, also in the ablative setting, this vein needs to be directed with special care.

The shunt classification is difficult, because two saphenous veins are involved: The reflux source is the SSV, draining the reflux in the proximal prolongation under the fascia (or epifascial in a tributary). The pathologic amount of blood ascends to join the GSV at the proximal thigh via the posterior accessory saphenous vein or a tributary, with sub- or epifascial course (N2 or N3, classified as transversal N4, as it connects two saphenous veins). The GSV is competent in the groin and gets incompetent fed from the blood from the SSV recirculation. Usually the refluxing blood drains into a tributary at knee level (above or below it). The most distal perforating vein is at the calf.

In case of diastolic reflux only, we find the following shunts (see Fig. 6.44):

- A shunt type 3 for the SSV (**N1 → N2 → N3** – N2 – N1)
- A shunt type 5 for the GSV—considering the SPJ as a perforating vein in this case: N1 → N2 → **N3 (Giacomini vein) – N2 → N3 – N1**

During the investigation of the reflux in the SPJ, it is important to discriminate between systolic and diastolic reflux—often both are present. This is fundamental for the treatment decision. In case of obstruction of the deep veins in the thigh after thrombosis or muscular dysfunction, the Giacomini vein is a good draining path for the blood of the calf. During systole, the blood will be expelled through the SPJ and the SSV into the Giacomini vein, drained via the GSV and SFJ into the proximal common femoral vein. This is an open bypassing or vicarious shunt, which should not be interrupted to avoid bothering recurrences at the knee level. It can be combined, with a closed diastolic shunt, concerning the

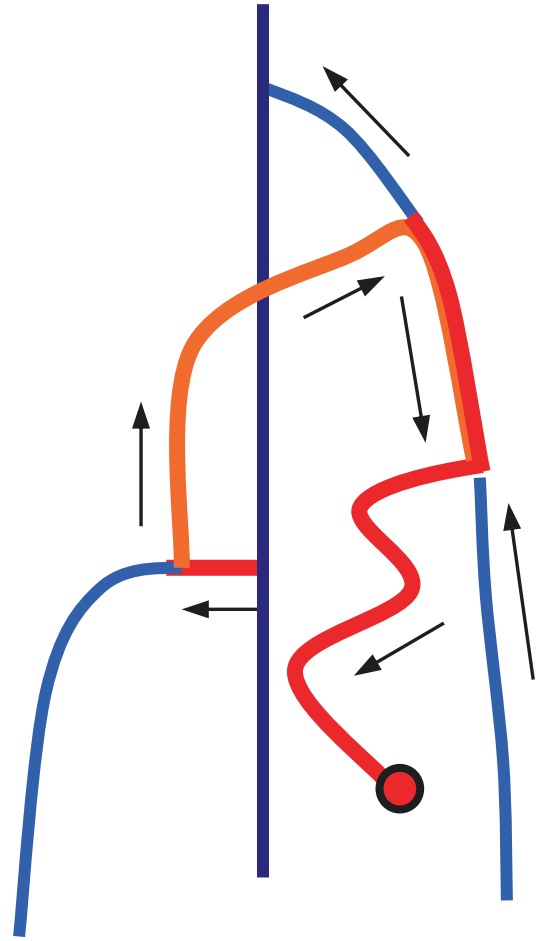

Fig. 6.44 Incompetent SPJ with reflux into the SSV, feeding the Giacomini vein (coloured in orange for differentiation). At the junction with the GSV, some of the blood drains antegrade via the SFJ into the common femoral vein (open deviated shunt if diastolic, open bypassing or vicarious shunt if systolic) and some of the blood fills the distal GSV retrogradely, draining to the deep vein via a tributary (closed shunt). N1 → N2 → TN4 (GV) – N2 – N1 / N2 → N3 – N1. With permission by [10]

GSV—which can easily be treated without interrupting the open shunt (see Fig. 6.45a, b).

As the treatment options are varied, they shall be analysed in detail.

In case that the Giacomini anastomosis runs under a fascia: The treatment is to disconnect the tributary from the GSV with flush ligation (green line in Fig. 6.45a). The whole recirculation then usually regenerates producing antegrade flow in SPJ as well as in the preoperatively refluxing segment of GSV. Sometimes after this tactic, no reflux is seen in the tributary or the GSV, but there is still an open shunt (Fig. 6.45b): reflux from the SSV into Giacomini anastomosis draining into GSV and flowing antegrade to the SFJ. If there is no pain in the fossa poplitea, this condition will not be noticed by the patient nor shall it bother the leg circulation and might be left untouched but observed regularly.

In case the Giacomini anastomosis has extrafascial segments, perform flush ligation of the tributary when emerging the fascia. Figure 6.45c shows the situation in case the tributary emerges directly from the SSV. It might also emerge on the running of the proximal extension of the thigh higher up; in that case the flush ligation has to be performed at this branching from the subfascial to the epifascial vein. Then, the post-operative examination will show an antegrade flow in the SPJ.

If the SPJ is very dilated preoperatively with SSV diameters higher than 10 mms, it should be considered to perform a flush ligation of the SSV at the popliteal level—but only if there is no systolic reflux, which would lead to a high recurrence rate and an impairment of leg drainage.

Of course, attention has to be paid to possible perforating veins in the course of the Giacomini anastomosis on its running on the back of the thigh—these should be treated according to CHIVA principles (see Sect. 6.9).

6.11.6.2 Connection via a Calf Tributary

As presented in Sect. 3.5.4 and Fig. 6.46, the reflux from the GSV can be drained via a con-

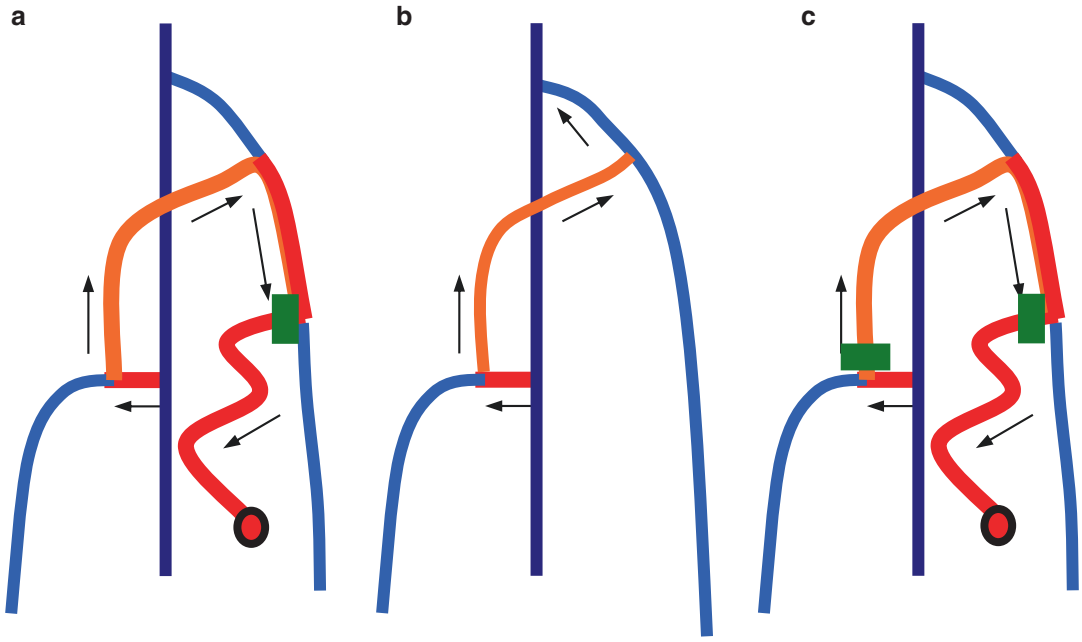

Fig. 6.45 Recirculation via the Giacomini anastomosis coloured in orange for differentiation. (**a**) Treatment option with subfascial Giacomini anastomosis. (**b**) Possible result after strategy described in **a**. (**c**) Treatment option with epifascial Giacomini anastomosis (and after excluding an open bypassing shunt). With permission by [10]

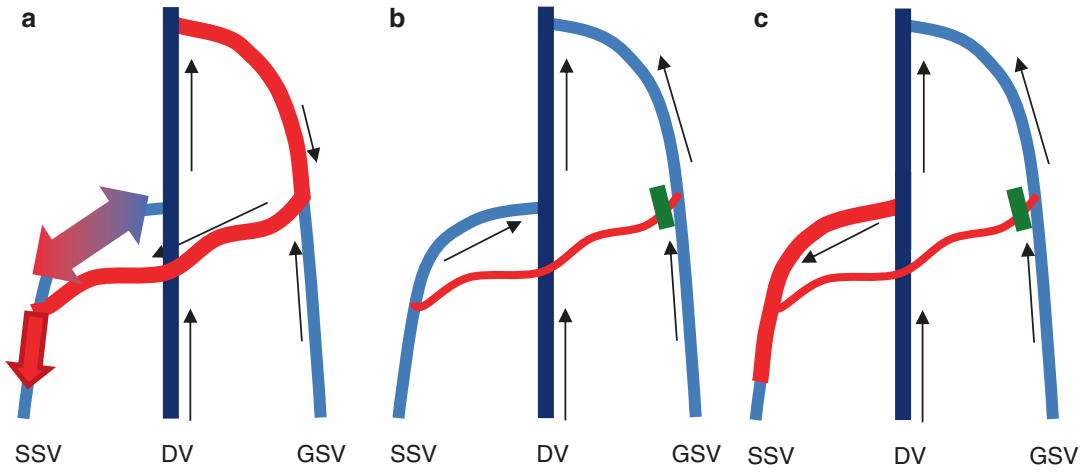

Fig. 6.46 Drainage from a refluxing GSV through a connecting vein between GSV and SSV. (**a**) Preoperative situation: Proximal SSV is enlarged, with antegrade and retrograde flow during diastole. (**b**, **c**) Situation after interruption of the tributary at the level of the GSV, assuming a flow correction in the GSV, which is not relevant to the evolution of SSV. (**b**) The SSV has recovered completely, no reflux. (**c**) The SSV is still refluxing, a second treatment session will be necessary to treat the persisting reflux. With permission by [10]

necting tributary (N3 or transversal N4) with the SSV. Initially the reflux might be drained via the junction, but after some time and with progressive dilatation of the proximal SSV, this will become incompetent, too. Another scenario would be an open systolic bypassing shunt starting at the sapheno-popliteal junction, feeding the SSV and the calf transversal N4 and thus the GSV, which might be competent and draining the flow, until it dilates too much, reverting the flow in diastole and becoming incompetent, too.

Thus, it is very important to double check systolic and diastolic flow when both veins are involved and to try and find out which vein was the first one with reflux, for example, asking the patient, where the first veins were observed on the leg. Another technique is comparing the PW reflux curves in both saphenous veins. The draining ones will show antegrade flow during diastole or a flow to and for.

The vein suspected as secondary filled should not be treated in the first session, as it often recovers completely (see Fig. 6.46).

Another possibility is a primary reflux source in the SPJ, filling the SSV, draining through a tributary into the distal GSV—the proximal aspect of this vein is competent. Usually the treatment of the SSV will solve the reflux situation in the GSV.

6.11.7 Remodelling a Refluxing System

In some cases, there is a very large reflux amount through a junction or a perforating vein with a great number of divisions along the tributaries. In other cases, the tributaries and reentry perforating veins are large, meandering and difficult to analyse. Obviously, these patients do not have high cosmetic claims, otherwise they would not have allowed the veins to develop to this point. In these cases, the treatment is required for pain or discomfort or skin changes. And in these advanced cases, we always find a shunt type 1 or 3 with reflux from the deep venous system.

Applying the four standard requests for CHIVA—interruption of the reflux source, subdivision of the pressure column, saving the reentries and eliminating the non-draining tributary system—lots of divisions should be applied. But the larger the vessels, the higher

the risk of a superficial vein thrombosis (see Sect. 10.1.4).

It is possible to treat the system in two or more steps: Starting with the interruption of the reflux source (junction or perforating vein), apply low dose heparin for 2 weeks and compression for some weeks or months and wait for calibre reduction in the system [5]. Often patients are so happy to have lost the symptoms just with this step that they do not want to undergo further steps. Or in the post-operative visit after some months, it becomes obvious that some further interruptions make sense—which can then be carried out in a second step.

This strategy is especially useful in patients with skin changes at the calf, allowing a recovery of the skin and incisions with less risk of infection or bad healing.

6.12 Non-haemodynamic Saphenous Vein Sparing Treatment

Sometimes decisions in medicine are subjected to extern necessities, like rules by health-care insurances or other socio-economic reasons. Thus, the treatment of varicose veins in some countries has to be successful after one session; re-interventions or re-investigations are not possible.

As described in Sect. 6.4.1, the treatment of shunt type 3 is not possible in one step—over 70% of the cases will need a second step intervention if starting with first step of CHIVA 2 [13] or a poor cosmetic result if starting with crossotomy.

6.12.1 CHIVA 1 + 2

Performing both steps of CHIVA 2—the tributary interruption and the crossotomy—is called CHIVA 1 + 2.

Applying crossotomy (interruption of the SFJ) and tributary interruption simultaneously, the primary reflux source is interrupted and the tributary will no longer be filled. The cosmetic result will be achieved and the reflux source interrupted (see Fig. 6.3 right and Fig. 6.47).

The problem is that in 38% of cases, the GSV between both interruptions will suffer thrombosis (see Sect. 10.1.4). And as a consequence, spider veins can appear at the thigh due to poor drainage of skin veins, the same as observed after stripping (see Sect. 10.2.2). In some situations, the risk of matting is not the central problem but the quick treatment of an ulceration or severe skin changes, e.g. in adipose persons. In these cases, a CHIVA 1 + 2 procedure might be an option to make sure the target will be reached soon.

To avoid these thrombosis/matting problems, the devalvulation of a segment of the GSV was developed to be applied in the same session with CHIVA 1 + 2 (see Sect. 6.4.2).

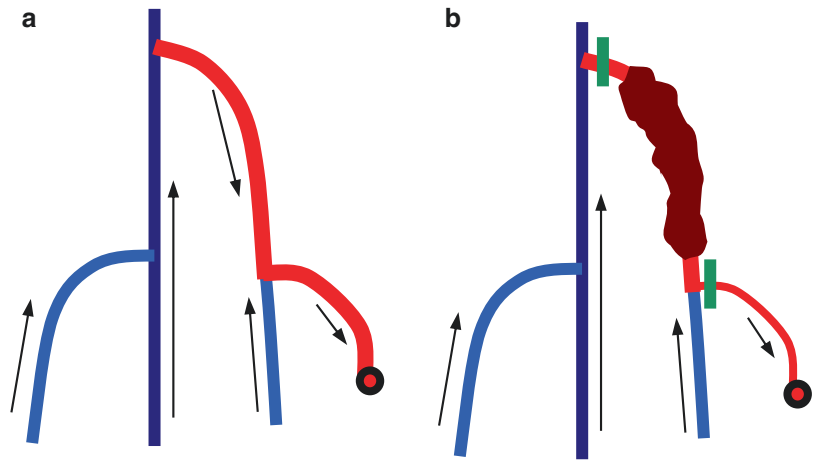

Fig. 6.47 (**a**) Shunt type 3. (**b**) Non-haemodynamic treatment with crossotomy and tributary interruption (CHIVA 1 + 2), leaving the GSV without drainage. This leads to thrombosis or poor drainage of GSV. With permission by [10]

6.12.2 How to Avoid Non-Drained Systems

Non-drained systems lead to spider veins and early recidives through subcutaneous vessels, mostly bothering the patient. The advantage of stable draining vein situation after regular CHIVA is lost might be the one responsible for less recurrence rate as compared to stripping.

In the situation of shunt type 3, the devalvulation was the answer to the unsatisfactory non-drained situation after CHIVA 1 + 2 (explained in Sects. 6.4.2 and 6.12.1).

Thus, especially during the learning curve, seeking for good drainage of all treated segments should be a high goal. As a first step, the analysis of the preoperative situation is very important, also to verify after a failure what could have gone wrong.

If a perforating vein or tributary does not seem to be sufficient to deal with the drainage of a segment, it is best not to do all the possible interruptions in the first step. This is especially important when starting to do CHIVA. Usually surgeons are used to do lots of incisions and tend to plan too much interruptions to achieve a result as good as possible. But just in the learning situation and in doubt if an interruption is necessary, it would be best just to close the most important insufficiency point and leave all the others for a second moment, months later, if they still seem necessary to be treated.

In any case, apply the manoeuver described in Fig. 6.2 before treating a tributary.

6.13 Management in Cases of Preoperative Thrombosis of Superficial Veins

Occlusion due to thrombi makes diagnosis of reflux more difficult, because thrombi close the veins partially or completely. This falsifies the drainage scheme from varicose veins, which is one of the most important bases for decision-making in CHIVA. It is therefore advisable always to try to clear up the thrombosis first by treatment with conservative measures. However, this is not always possible, and the patient must then be treated despite the thrombosis.

In such cases, the recommendation is to limit treatment to interruption of the proximal reflux source. Since the result of this is to further reduce the velocity of blood flow in the occluded region, it is likely that the thrombosis will get worse immediately after the operation. It is therefore recommended to treat these patients with low molecular prophylactic heparin for 10–14 days after the intervention and non-steroidal anti-inflammatory drugs for the first week and then to explore the patient again and to decide whether to give more heparin depending on the calibre reduction of the saphenous vein: good reduction (no more heparin) and no reduction (go on with heparin).

Superficial vein thrombosis after CHIVA will be discussed below (see Sect. 6.14.5). CHIVA treatment in case of deep vein thrombosis is addressed in Chap. 9.

6.14 The Post-operative Examination

The patient should come in for a duplex ultrasound post-operative examination after some months, the earliest to see changes 8 weeks after the operation. Earlier than these changes in the venous system are not established—in some patients it takes even longer.

Apart from examining the vein calibre reduction, the doctor must also find out whether the patient's preoperative distress has changed.

Patients can sometimes feel when new connections open which previously did not exist or were not refluxing. So, it may occur that the clinic, cosmetic and duplex ultrasound findings after a surgery are good, but the patient complains of pains, for example, at the inner thigh after interruption of the SFJ. He can even put his finger on the exact spot. Almost always a (still) thin but refluxing perforating vein can be found, which in a few weeks will again deliver reflux into the GSV. It should be interrupted immedi-

ately before it provokes cosmetic complaints. It is not necessary to await development. If the patient wants to postpone the complementary operation to a later date, however, it has to be explained to the patient that new visible varicose veins will appear.

6.14.1 Post-operative Examination of the Junctions After Interruption

The documentation must record (even if only as a note in the file without an image) whether the SFJ or SPJ was closed and how much flow entered the saphenous trunk vein from the superficial inguinal tributaries or the vein of Giacomini. Otherwise it will be impossible later to find the correct cause in the event of recurrence. If the SFJ or SPJ is not closed, it will have to be re-treated. This is very important in CHIVA, as different from the ablating techniques, a residual reflux will very soon express as new visible veins using the non-destroyed pathways. In case of a non-complete crossectomy in the stripping context, it takes years until veins visible in ultrasound after the intervention are clinically relevant.

6.14.2 Post-operative Examination of the SFJ and SPJ After CHIVA 2

After CHIVA 2, the SFJ and SPJ are examined under the same criteria as in the preoperative examination. If the junction is competent, the patient will be called in for regular check-ups. If the junction is incompetent, further procedure will depend on the finding (see also Sect. 6.4.1):

- If there is only minimal reflux, perhaps only under Valsalva, and the patient is otherwise free of distress and satisfied, it is safe to wait a couple of months before carrying out an interruption of the junction. The GSV sometimes requires rather long to further reduce the diameter and may get competent later.
- If there is still a reflux and a new tributary has opened to carry the reflux, the junction must be closed without long delays, because any delay may allow the condition to become aggravated unnecessarily.
- If there is still a reflux and a perforating vein has opened to drain this reflux from the saphenous vein to the deep vein without cosmetic visible branches and no distress for the patient, the situation may be stable for a long time and could be observed until new problems occur, which may then be treated as a shunt type 1. This has to be explained to the patient. If the patient is not able to come in for follow-ups, the immediate interruption of the junction might be the better option.
- If the ligated CHIVA 2 point has reopened or small bypasses have formed, the SFJ must also be treated. A new interruption in the same spot makes little sense as we have noticed in our experience. However, if the CHIVA 2 point was not interrupted properly as flush ligation at the saphenous vein (see Sect. 4.11.2), the correct procedure is to interrupt it again right at the saphenous vein. This extends the treatment considerably for the patient, as he must now wait another 8 weeks to see whether junction needs to be operated.

6.14.3 Post-operative Examination of the Saphenous Veins

If a saphenous trunk vein was refluxing before the operation, the velocity profile and the diameter must be compared with preoperative findings. Some little flow allowing drainage of tributaries to the next perforating vein is normal. In PW mode, the curve will be slow and not long-lasting—about 1 or 1.5 s, this was called "deflusso" in Italian to differentiate it from "reflusso" (reflux; see Sects. 4.11.1 and 6.3.4.1), but a long-lasting reflux of great amounts of blood is no good outcome. If reflux still exists after the operation, the proximal reflux source which was interrupted in the first operation must be examined, and the whole course of the tribu-

taries and perforating veins must be checked for participation in the reflux. If a perforating vein has become refluxing, the saphenous vein must be interrupted below it or the perforating vein itself (see Sect. 6.9). If the vein is filled from a tributary, the reflux source in the tributary must be treated.

6.14.4 Post-operative Examination of the Tributaries

In tributaries, which continue to carry reflux, the same strategic criteria apply as in the first operation. If a tributary is still visible but not carrying large amounts of reflux, it may not be able to reduce its calibre due to wall damage as a consequence of prior thrombosis or wall lesions. Phlebectomy or sclerotherapy can be recommended, because a calibre reduction may then no longer be expected.

In case of residual reflux with partial calibre reduction but with a long segment (high pressure column), an interruption at a branching point can be planned, a phlebectomy or a sclerotherapy.

6.14.5 Post-operative Superficial Vein Thrombosis

Superficial veins may develop a thrombosis after CHIVA that is why in some cases prophylactic doses of heparin are applied post-operatively (see Sect. 10.1.4).

In case of a thrombotic occlusion of the saphenous vein after CHIVA 2, the risk of ascension to the deep vein is given, and it has to be treated to avoid deep vein extension via a junction or patent perforating vein. As found by Pintos (see Sect. 10.1.4), GSV with diameters at proximal thigh over 8.5 mm are more prone to thrombosis. That is why in these patients the SFJ should be treated in the first step in case of shunt type 3 to avoid this possible ascension of thrombi to deep veins. In the author's experience, giving heparin for 10 days as a rule after CHIVA 2 and avoiding CHIVA in two steps in case of large, aneurysmatic veins have made proximal thrombosis anecdotal.

Surprisingly thrombotic occlusion of saphenous veins after CHIVA crossotomy rarely causes pain to the patient, so often it is an incidental finding of the duplex investigation.

Thrombotic occlusions may falsify the outcome of the post-operative examination. Thrombosis in the GSV in the thigh region makes it impossible to measure the post-operative flow of the GSV. Furthermore, if the saphenous trunk is incompetent, a tributary occluded with thrombosis can falsify the evaluation of the proximal segment, since any reflux which might exist in this tributary cannot be measured in the presence of thrombosis.

Therefore, in cases of superficial vein thrombosis, the situation must be evaluated with caution. It is better to call the patient back for examination once the thrombosis has healed. Usually, in asymptomatic patients after crossotomy, no medicaments are necessary: A progression to the deep vein via the junction is no longer possible, in the absence of large perforating veins, a progression via a perforating vein neither. The thrombosis will resolve spontaneously within the longest 12 months.

6.15 Recurrence Management

6.15.1 Recurrence After CHIVA

Complementary interventions after 6–8 weeks, which are necessary in some patients and are consciously planned when deciding the strategy, are not a recurrence treatment but a completion of the CHIVA treatment.

Recurrent veins are situations in which patients who had no varices and no distress when released after CHIVA present new varices in the same places or at other points after some time.

6.15.1.1 Recurrence at the Saphenofemoral Junction

A recurrence after crossotomy can be noted clinically (new visible veins) or by duplex: a reflux

re-appears in the GSV which was "draining" in the first exploration after the intervention. Duplex examination can indicate the new reflux source: recanalisation of the interruption of the junction or refluxing pelvine vessels meeting the GSV distal to the groin, perforating veins or other tributaries.

Recanalisation of junction: Redo the interruption and consider what went wrong. Remember: At this site, non-absorbable suture material is mandatory.

Reflux from supra-inguinal vessels: A treatment of these vessels at their origin may be planned at P or I point. Alternatively, multiple vessels seen on the proximal aspect of the thigh (medial or inguinal) may be treated with sclerotherapy to reduce the reflux into the GSV. Another option—in case a pelvine leak point surgery is not available and the vessels are too large to be treated with sclerotherapy—could be the closure of the proximal 5 cm of the GSV with endoluminal heat devices, applying sclerotherapy through the device into the supra-inguinal feeding vessels. This avoids sclerosing damage to the distal GSV.

In 20 years of experience, the author has never seen a "cavernoma" with multiple little vessels in the groin after CHIVA crossotomy as it is observed after crossectomy and stripping, excepting for one case of an obese, diabetic person under corticoids for rheumatic disease that developed an infection of the groin after surgery for C6 varicose veins. In this case, the vessel neoformation possibly was triggered by the infection.

When performing CHIVA with endoluminal heat closure of the proximal segment of the GSV (see Sect. 7.13), the most frequent recurrence is from pelvic vessels or the junction into the anterior accessory saphenous vein (AASV) (see Sect. 4.11.4). The best form to prevent this is treating the AASV during the intervention (e.g. with 0.5 cc of 1% foamed sclerosing agent), if it is visible and dilated. In any case, the patient has to be informed that possibly this vein will be treated in the second appointment, which can easily be done with a little amount of ultrasound-guided sclerotherapy into the AASV when the reflux is first noted to avoid clinical recidives.

6.15.1.2 Recurrent Veins Along the Saphenous Veins

As the GSV is left in situ, any pathologic amount of blood meeting the vein will be transported. In antegrade direction, if the valves have recovered and only first step of CHIVA 2 was performed, but retrograde if the SFJ was closed. Clinical recurrence will not last years until vessels develop. Thus, as soon as tributaries develop, the reflux source should be looked after and treated, given the consent of the patient. Recurrences after first step of CHIVA 2 are explained in Sect. 6.4.1.

Reflux from tributaries at the thigh into the GSV: Treat the tributaries (close origin, miniphlebectomy, sclerotherapy) and the flow into the GSV will reduce back to physiologic.

Reflux from a perforating vein into the GSV: Consider interrupting the perforating vein or the GSV distal to the perforating vein to provoke a change of flow to the deep vein, depending on the position of the perforating vein (the higher, the better it is to close it, the nearer to the foot, the better it is to use the perforating vein to drain the blood from the GSV) (see Fig. 6.26).

Drainage of the reflux into a new cosmetic disturbing tributary: In this case the optimal solution can be given if a perforating vein is found on the GSV—the tributaries can be disconnected from the GSV, leaving the perforating vein untouched as physiologic drainage for the GSV (see Fig. 6.25).

6.15.2 Recurrence Management After Ablative Procedures

After ablation of the saphenous trunk, CHIVA can only be used under certain conditions. The normal N2 drainage routes are no longer available. However symptomatic patients can be helped by volume relief by applying the rules of "interruption of the escape point" and "preserving draining routes" to the recidive.

The following situations may arise in recurrence of varices:

- **Recurrence at the sapheno-femoral or sapheno-popliteal junction with left stump and visible valves**:
  - (Re-)Crossectomy of the junction as the sole treatment. Plenty of dilated and visible tributaries regenerate by themselves as a result, and clinical complaints disappear. At the post-operative examination after 6–8 weeks, residual reflux sources may be found in the rest of the leg; they can be treated under local anaesthetic or with sclerotherapy.
  - Consider sclerotherapy if the stump is short, and the new tributaries have small diameter.
- **Recurrence at the SFJ or SFP with no stump but diffuse little vessels**:
  - Often these diffuse vessels ("cavernoma") are not filled by the deep veins but by pelvine refluxing vessels [20]. Consider treating the pelvic leakage points.
  - Alternatively, ultrasound-guided foam sclerotherapy of the refluxing vessels in the groin with no surgical intervention to reduce the pressure in the leg superficial veins. Wait and see for the rest of the visible vessels, which may disappear afterwards.
- **Recurrence from perforating veins**: This kind of recurrence is most frequently found around the perforating vein of the adductor canal (formerly Dodd).
  - In case of large reflux volume, the perforating vein can be surgically interrupted below the fascia surgically, possibly in combination with sclerotherapy (see Sect. 7.12).
  - In case of a thin perforating vein with little reflux, it may be less traumatic to perform a sclerotherapy of the perforating vein under duplex guidance or with endoluminal devices.
- **Persistence of a section of the GSV**: After stripping "from ankle to groin", segments of the GSV may still be found between the fasciae (easily recognised in ultrasound by the "saphenous eye" (see Chaps. 2 and 4)). In these patients, the stripping probe has slipped into a large epifascial vein when pushed through the GSV. If these remains of the saphenous vein are refluxing, classic CHIVA strategy decisions must be used.
- **Reflux from a perforating vein into a subcutaneous venous network**: Multiple small refluxing vessels develop in scar tissue of a perforating vein interruption. Normally a sclerotherapy may be enough as a treatment; alternatively the perforating vein has to be interrupted.
- **Varicose tributaries**: These must be treated in exactly the same way as varicose tributaries in the untreated leg. Nevertheless, it must be borne in mind that the affected veins are often poorly drained, so miniphlebectomies or sclerotherapies are advisable.

6.16 Getting Started

After learning about CHIVA, sometimes it is difficult to get started. Colleagues of the own team mostly are not convinced that this could work. The patients (and most of all the doctors!) are used to be "ready" after one session, even though often further sclerotherapy sessions are necessary also in patients after venous ablation. They fear that patients will be unsatisfied, if they learn that a second step is to be done. The surprising fact is that patients often are happy when they are told that we are doing the less possible harm, even though this means they have possibly to return for a second little intervention.

A starting difficulty is, as every surgeon knows, that in practice we meet lots of conditions influencing a decision, not included in the images presented in this chapter.

So, it is important to take some time to investigate and document the findings prior to intervention and to be patient with ourselves with these first cases. Routine comes by doing.

6.16.1 General Strategic Decisions

When doctors start using the CHIVA method, they often ask which patients are ideal for their first attempts. These are:

- Young patients with shunt type 5 and a reflux only above knee, where the first step of CHIVA 2 can be applied expecting not to need the second step.
- Patients with expressed varices and shunt type 1 are also ideal, so long as one can resist the temptation to make a lot of incisions on the first day. In these patients, one can get a feeling for vein regeneration after the sole treatment of the junction.
- Multi-morbid patients with high C classes (CEAP) where it is possible only to treat the vessel feeding the skin changes or only the junction—an affordable intervention even in anticoagulated persons under local anaesthesia.

It is important that the first patients are themselves convinced by the CHIVA method. As a second or even third operation is sometimes necessary for a definitive solution during the learning curve, the subject must have patience and cooperate; he is more likely to be motivated if he himself chose the operating method and is convinced that keeping the saphenous trunks is the best option for him.

It must be made very clear to the patient before the intervention starts that the treatment does not end with the first operation. He will have to come for a post-operative examination after 2–3 months, when a complementary operation may be necessary, and he has to know that veins will be visible weeks after intervention. But in nearly all of the cases, he will be able to return to work within little time, and the venous complaints will disappear quickly.

For strategic decisions, it is also advisable to clarify with the patient in advance whether his distress or the cosmetic outcome is more important. If the cosmetic outcome is very important, in cases of shunt type 3 or 5, the tributaries must always be interrupted first and a part removed. If the patient is more concerned about the symptoms, treatment should concentrate on the highest reflux source. If the diameter of the GSV is larger than 10 mm at the thigh or have aneurysmatic dilations in the groin, the SFJ should be operated in the first session, regardless of the shunt type to avoid ascending thrombosis. Operating on the SFJ in the first session in shunt type 3 with a venous ulcer may also be considered. However, the outcomes of shunt type 3 treatment are clearly better when the tributaries are treated first at the CHIVA 2 points.

There are also fearful patients, who by nature prefer CHIVA to stripping. If a patient wants "only a few incisions" per session, this procedure is still possible, but it must be explained to the patient that more sessions may be required in total. In these cases, one should always take the most important step first. In other words, in shunt type 1, the SFJ is always treated first, and in a shunt type 3 or 5, the CHIVA 2 option is the first step.

Even strongly expressed varices, with large calibre and presenting big tributary convolutes, can be treated with CHIVA. However, doctor and patient must both appreciate that the treatment time will be longer than with less strongly expressed varices. That means more appointments and longer examination times per appointment. The risk of superficial vein thrombosis is also higher with strongly expressed varices (see Sect. 6.16.2.1).

6.16.2 Case Examples

6.16.2.1 Large Varicose Veins

A 52-year-old male patient with fears of anaesthesia and absolute negation to undergo stripping, this is the reason why he searched a centre applying CHIVA. Little distress, rarely wearing compression stockings, but fear of progression and thrombosis. This is surely not an optimal case to get started at the first sight, but as the patient is convinced not to want an ablation of the vein, it is a good case to learn what just little gestures can do with large varicose veins:

Findings: incompetent SFJ and 11 mm diameter of the GSV at the proximal thigh. Winding refluxing tributary, filled in the thigh 15 cm below the SFJ (preoperative finding; see Fig. 6.48a, b, blue arrow). Convolute below the knee, filled from this tributary with draining into the distal

GSV. Shunt type 3 with no perforating vein on the GSV at the thigh.

In the first treatment session (28.11.2001), only the SFJ was interrupted to produce a reduction in the calibre of the varicose vein (see Fig. 6.48c).

At the first post-operative examination (15.01.2002) (see Fig. 6.48d), a good reduction in calibre was found with partial thrombosis in the tributary without clinical complaints but also partial flow in the tributaries. The tributary was now interrupted at its junction to the GSV (position of blue arrow in Fig. 6.48a, b), and two stab incisions were made in the occluded convolute below the knee intending to express thrombotic material, which would not be successful. No interruption was performed at the knee site.

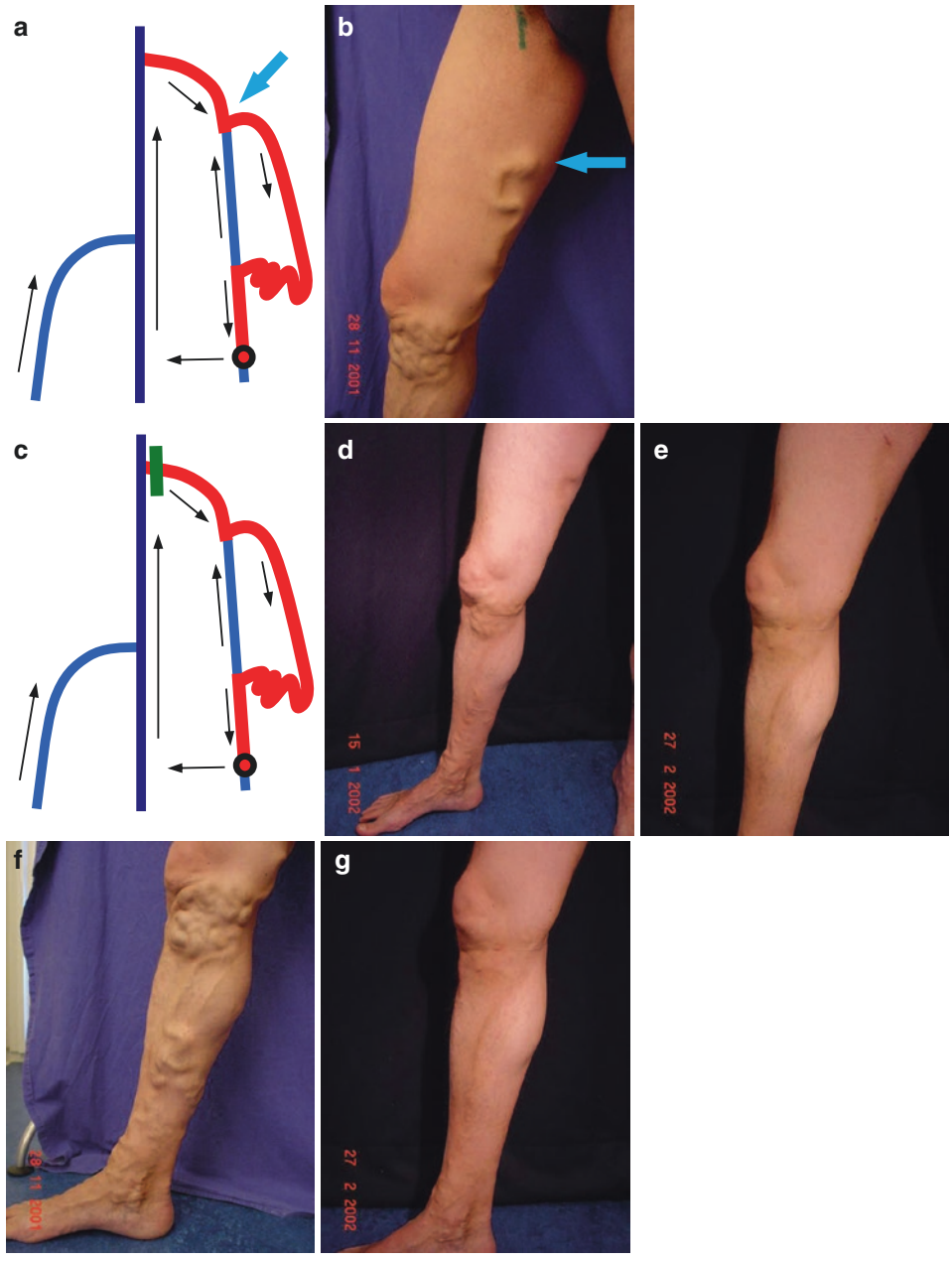

Fig. 6.48 For description of the case, see text. With permission by [10]

In the re-examination on 27.02.2002 (see Fig. 6.48e), the patient is completely free of distress. Slight discolouration of the skin along the course of the GSV, which experience tells us, will fade after a couple of months. At both the operation sessions, low molecular heparin in prevention doses was prescribed for 10 days.

Summary: Preoperative situation, detail of the knee and calf before intervention (Fig. 6.48f). Crossotomy at the first session (28.11.2001) and tributary disconnection at the thigh at the second session (15.01.2002). Control 3 months (27.02.2002) after first intervention only discolouration of the skin, no reflux. No clinics. The patient had 2 days loss of work (just the intervention days).

6.16.2.2 Avoiding Difficult Surgery Access

Varicose tributaries are often a cosmetic problem for the patient. Sometimes in case of reflux of SSV with an early drainage through a tributary, the classic intervention would be a crossectomy, stripping of SSV and exhairesis of the tributary. In the situation presented in Fig. 6.49, the indication to such an intervention with the risk of neural lesion is hard to be justified. CHIVA 2 is always a good option in these cases with less surgical risk.

Another option to avoid surgery in the knee crease is to apply endoluminal heating devices to close a short segment of the SSV—although no results have been published so far.

Figure 6.49 shows a not very strongly expressed finding of a shunt type 3 on a SSV with a high and lateral sapheno-popliteal junction. Slight discomfort when working in the squat (the patient was a nursery school teacher). Surgical access to the junction would have meant a large incision and post-operative pain.

CHIVA 2 was applied, which indeed required a relatively large incision (exposure of the SSV junction of the tributary, as it was a CHIVA 2 point). With a mini-phlebectomy, it would have been necessary anyway to make several small incisions—and recurrence would certainly have occurred if the CHIVA 2 point had not been interrupted flush at the SSV level. According to CHIVA therefore, a proximal incision would have been made in any case in this patient, even if treatment was completed with distal mini-phlebectomies.

At the control 2 months later, little rest of varicose veins were seen, and the SSV was competent and stayed at the visit after 1 and 3 years. The remaining findings (Fig. 6.49c) can be treated with sclerotherapy if wished. The discomfort of the patient had completely disappeared.

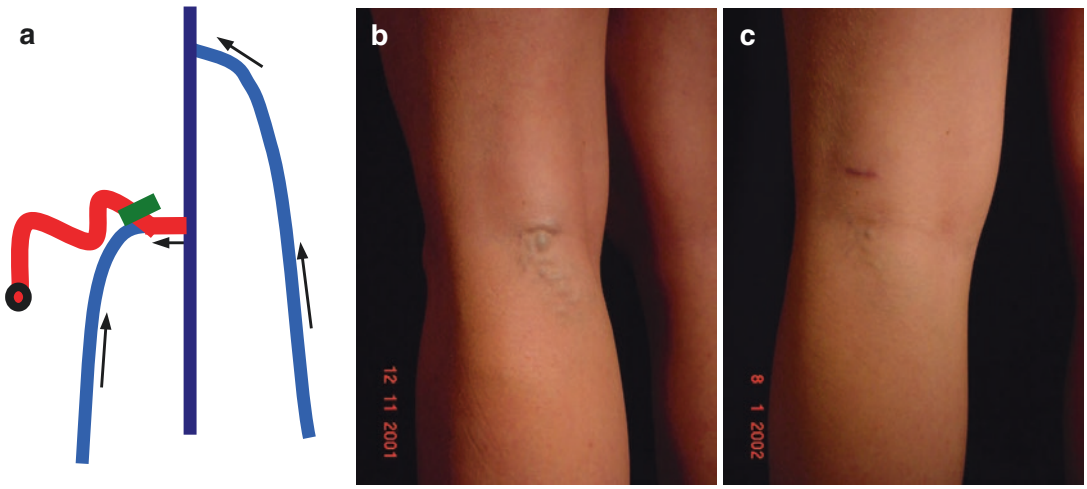

Fig. 6.49 For explanation to the case, see text. With permission by [10]

6.16.2.3 Treatment Involving Refluxing Accessory Anterior Saphenous Vein

The situation of the AASV differs from that of other tributaries. It forms part of an extensive venous network in the front of the thigh, so that in some patients, even if there is no more reflux from the deep veins after the operation, the veins continue to be filled by physiologic draining tributaries and produce cosmetic inconvenience.

In this case, a woman with shunt type 3, incompetent terminal and competent preterminal valve, reflux through SFJ escaping into AASV and after approximately 15 cm subfascial reflux the AASV pierced the fascia becoming clinically evident. Between AASV and GSV, two connecting veins were found, draining refluxing blood into the GSV (blue lines between GSV and AASV in Fig. 6.50a). The interruption of the AASV at its junction with the GSV was the haemodynamic solution of the problem; GSV was found to be antegrade in the follow-up. But the cosmetic bothering tributary would not have reverted properly for it was very large. So, miniphlebectomies were performed at the level of the blue arrows in Fig. 6.50a, b. The green arrow shows the point, where the tortuous tributary drains into the GSV; below this point, no more phlebectomies were performed. After 5 months (Fig. 6.50c), the vein at knee level (below the green arrow), which had not been extracted, has reduced its calibre; the patient was free of complaints.

The combination of CHIVA at the proximal reflux source with phlebectomy of particularly disturbing sections saves on incisions and produces good outcomes, as long as drained segments are the result. In this case, this was possible thanks to the connections between the AASV and the GSV. It is not good to interrupt the AASV on its course indiscriminately without paying attention to the drainage of the proximal segments—in this case non-drained segments with matting and early recidives will be produced.

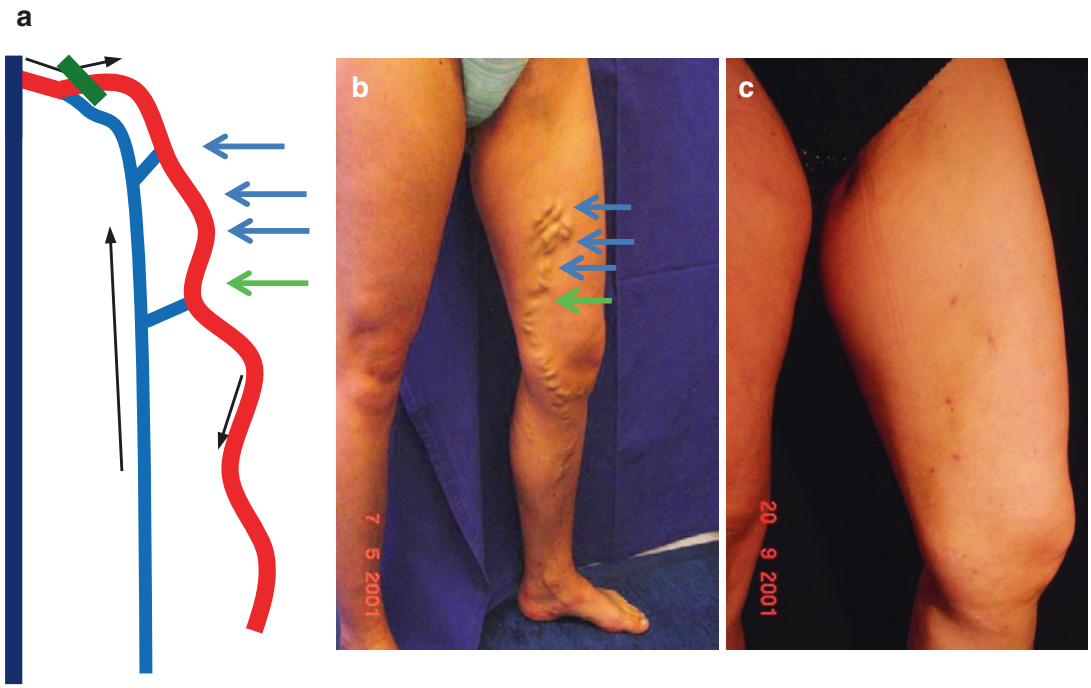

Fig. 6.50 For explanations of the case, see text. With permission by [10]

Last, not least and again, it may be stressed: When starting with the CHIVA strategy: the fewer the incisions, the better the outcome, even if this sometimes means that some sessions are necessary.

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