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Short endovenous laser ablation of the great saphenous vein in a modified CHIVA strategy

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Abstract

Mini-invasiveness, ease of use and execution speed represent the reasons for endovenous laser ablation success. Nevertheless, the strategic choice remains the ablation of the saphenous trunk. Hemodynamic correction (CHIVA) represents an option, based on a saphenous-sparing therapeutic strategy. We tested the feasibility of a modified CHIVA strategy by means of endovenous lasers (EL) shrinkage of segmental great saphenous vein (GSV) tracts, in networks characterized by sapheno-femoral incompetence and re-entry perforators focused on the GSV. We report the follow up of the first 2 chronic venous disease [$C_{1,2,3}sEpAsPr_{1,2,3}$, venous clinical severity score (VCSS) 8 and 9 respectively] treated cases. At 1-year follow up both patients were $C_{1,2,3}sEpAsPr_{1,2,3}$ and the VCSS were 1 and 2 respectively. The non-treated GSV tracts maintained their patency. ELs were herein used within a saphenous-sparing therapeutic plan, thanks to an accurate pre-operative hemodynamic assessment, which allowed the shrinkage of only the first saphenous trunk tract only. Proper technical and hemodynamic considerations are discussed.

Introduction

In the last decade, endovenous laser ablation (EVLA) has progressively dominated the chronic venous disease (CVD) therapeutic field.[1]

Nevertheless, strategically, EVLA hasn't brought any innovations, since its first description by Navarro in 2001:[2] the reflux abolition is obtained by the vein anatomical ablation, exactly like in surgical stripping.

Conversely, hemodynamic correction (CHIVA) constitutes an alternative strategic approach for CVD treatment: a saphenous-sparing draining restoration that is characterized by a scientifically validated efficacy.[3-5]

In order to combine the endovenous laser (EL) main technical strengths with the CHIVA strategy efficacy, an innovative therapeutic approach was used.

After an accurate pre-operative hemodynamic assessment, the great saphenous vein (GSV) was shrunk distal to the superficial epigastric vein confluence (SEV), just for 7 to 10 centimeters. The remaining trunk was left draining reversely toward a previously selected re-entry perforator. We herein present the first 2 CVD cases that were already assessed at the one-year follow up.

Case Reports

Diagnostic assessment

The first patient (case A) was a 47-year old male, with no co-morbidities, who was evaluated for a $C_{1,2,3}sEpAsPr_{1,2,3}$ CVD, which was first diagnosed 4 years before.

The clinical assessment assigned a venous clinical severity score (VCSS) of 8.[6]

The echo-color-Doppler investigation (ECD) identified a positive Valsalva and compression/relaxation (C/R) maneuver at the femoral side of the terminal valve,[7] an incompetent below-knee GSV tributary and an effective re-entry perforator on the mid-calf GSV trunk. According to CHIVA terminology, the patients presented a type I+N3 shunt (Figure 1).[8,9]

The second patient (case B) was a 64-year old male with arterial hypertension in the anamnestic record. He was evaluated for a $C_{1,2,3}sEpAsPr_{1,2,3}$ CVD, which was first diagnosed 3 years before. The clinical assessment assigned a VCSS of 9.[6]

The ECD revealed a reflux pattern that was overlapping with the case A one (incompetent sapheno-femoral junction, re-entry perforator focused on the GSV, incompetent GSV tributary, in this case located on the distal third of the leg, but however above the GSV re-entry perforator).

Case A and B hemodynamic measures are reported in Table 1.

Operative procedure

On the same procedural day, both cases underwent an accurate pre-operative echo-guided mapping.

Case A

On the mid-calf, a flush disconnection of the incompetent GSV tributary was performed, leaving the saphenous breach opened in order to directly insert a 600 mm radial fiber of a 1470 nm 6W EL (Figure 2).

Under ultrasound-guidance the fiber was then positioned just distal to the SEV.

A tumescent anesthesia (lidocaine 2% 5 cc + sodium bicarbonate 5 cc + saline solution 10 cc) was administered perivenously by a 25 G needle, under ECD guidance, just along the 10 cm below the SEV, with a 40 cc total injection.

The EL was then activated, shrinking the GSV at 100 J/cm and at 80 J/cm for the first 6 and the remaining 4 cm respectively.

The total energy delivery recorded the following parameters: i) laser on-time: 155 s; ii) total joules delivered: 928 J; iii) treated segment length: 10 cm.

After the fiber extraction, a 7/0 running suture was performed to close the saphenous breach.

Case B

A flush ligation of the incompetent GSV tributary was performed according to the CHIVA principles.[8,9]

Since the tributary was located on the distal third of the leg, percutaneous GSV access at the distal third of the thigh was preferred: with the patient in a reverse-Trendelemburg position, a 0.0035-in guide-wire was inserted through a 19 G needle into the GSV.

The same case A device was then introduced (1470 nm, 6 W) and placed just below the SEV.

The tumescent anesthesia was performed with the same compound, and injected perivenously along the 7 cm below the SEV, for a total amount of 30 cc.

Once the EL was activated, the GSV was shrunk at 100 J/cm and at 80 J/cm for the first 5 and the remaining 2 cm respectively.

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The total energy delivery recorded the following parameters: i) laser on-time: 111 s; ii) total joules delivered: 671 J; iii) treated segment length: 7 cm.

In both cases, eccentric compression with cotton rolls on the treated veins was applied underneath a 20-30 mmHg thigh-length elastic stocking that was prescribed day and night for one week and only daily for the following week.

The clinical and ECD follow-up was scheduled at 1 week, then at 1-6-12 months.

Results

The patients referred no pain linked to the peri- and post-procedural time.

Neither major nor minor complications were reported.

Only a minor tightness feeling was reported in case B, during the first week, all along the 5 cm distally from the EL treated segment. A total relief was obtained after 3 days of non-steroidal anti-inflammatory drugs. Already at the 1 week ECD, case A showed a perfectly shrunk GSV tract from below the SEV to 10 cm downward. At 1 year follow up, in both patients, the clinical evaluation assessed a $C_{1a}E_pA_sP_{r1}$ class, while the case VCSS was 2 in case A and 1 in case B. Table 1 reports the 1 year follow up hemodynamic parameters which were assessed at the mid-thigh GSV portion in both cases (Figure 3).

At the 1 week ECD, case B showed a perfectly shrunk GSV tract from below the SEV to 7 cm downward wall thickening, but also a wall thickening from the shrinkage distal end to other 8 cm downward (Figure 4).

The tract affected by this wall thickening was compressible, vascularized and spontaneously disappeared at the 1 month follow up.

In both patients, the 1 year follow-up revealed a totally patent GSV from the shrunk tract downward (negative compression-ultrasound maneuvers). At the compression/relaxation maneuver the junctional tributaries showed a systolic centripetal flow, draining into the sapheno-femoral junction (Figure 2). Post-operatively the stump was 10.6 mm and 10.1 mm long in case A and B, respectively. Placing the PW (pulsed wave) sample on the femoral side of the terminal valve both Valsalva and C/R maneuvers were negative for reflux. No ballooning during strain was observed in both cases

Pre-operatively the Giacomini vein was found to be competent in both cases. It was not identified post-operatively.

Discussion

The ever-increasing need for mini-invasiveness, fast recovery and painless procedures have permitted EVLA to become one of the main therapeutic option in contemporary CVD management.[1]

Certainly, this technique has brought great technical advantages, but, at the same time, no improvements have been obtained in the strategic planning thus far: the procedure is based on the saphenous trunk ablation, exactly like in surgical stripping.

The laser technique has brought great success in the quality of life improvement.[10] Nevertheless, the long term clinical and ultrasonographic results of this procedure haven't being correspondingly satisfactory.[11] The maintaining of an ablative strategy could be an explanation of the observed phenomenon and the herein presented strategy could offer an alternative model of venous hemodynamic investigation. On the contrary, the strategic

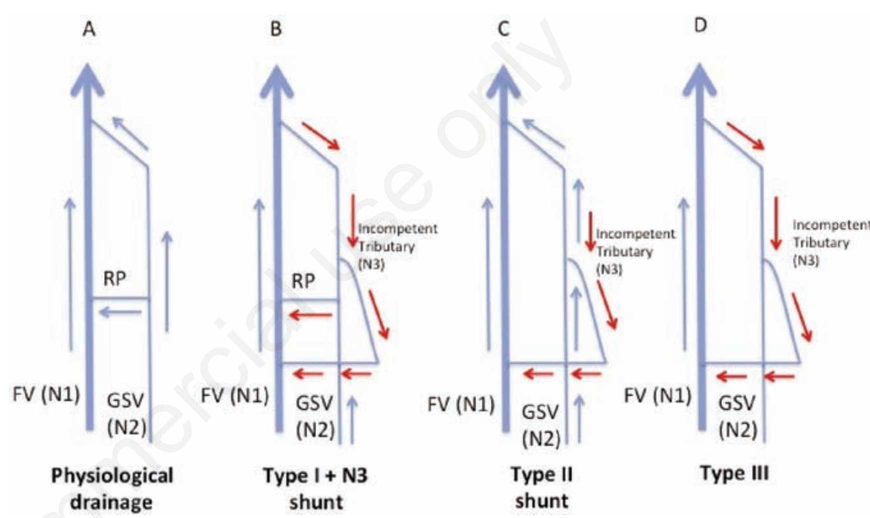

Figure 1. Femoral vein (FV), re-entry perforating vein (RP), and great saphenous vein (GSV). A) Physiological drainage: from the most superficial compartment to the deepest one, from the lowest to the upper part of the leg. B) Type I +N3 shunt: pathological inversion of the physiological order of emptying from N1 compartment to N2, adding an incompetent GSV tributary (N3). A re-entry perforator is focused on the GSV (N2). This allows the sapheno-femoral junction treatment. C) Type II shunt: Pathological inversion of the physiological order of emptying from N2 compartment to N3, with no compartment jump from N1 to N2. The incompetent tributary has its own RP directly draining into the N1 compartment, so that no closed circuits are formed. D) Type 3 shunt: pathological inversion of the physiological order of emptying from N1 compartment to N2, adding an incompetent GSV tributary (N3). No re-entry perforator is focused on the GSV. This forbids the sapheno-femoral junction treatment: in case of a sapheno-femoral junction disconnection/occlusion together with the incompetent tributary treatment would impede the draining into the GSV trunk so leading to thrombosis.

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Table 1. Morphologic and hemodynamic measurements recorded pre-operative and 1 year follow-up outcome both in case A and B.

	Case A		Case B	
	Pre-op	Post-op	Pre-op	Post-op
GSV diameter below the SEV(mm)	8.4	Totally shrunk	8.7	Totally shrunk
GSV diameter at mid thigh (mm)	8.7	3.9	8.9	3.4
Reflux time (s)	2.3	Down-word draining flow	2.6	Down-word draining flow
Peak systolic velocity (cm/s)	41.7	37.4	55.6	26.5
End diastolic velocity (cm/s)	–11.5	10.1	–11.7	4.3
Resistance index	1.27	0.73	1.21	0.83

GSV, great saphenous vein; SEV, superficial epigastric vein.

change that has been brought about by a saphenous-sparing surgical technique like CHIVA point towards better long term outcomes in CVD management,[4] with a halved recurrence risk if compared to traditional stripping.[3]

Interestingly, the sapheno-femoral refluxing point suppression by EL confirmed the creation of a not refluxing but rather reversed flow, draining the GSV trunk toward a re-entry perforator.[12]

Conversely, a strict application of the CHIVA principles would require the maintenance of the junctional tributaries draining into the GSV trunk.[8,9]

Certainly, the proposed segmental GSV shrinkage is feasible only in case of a re-entry perforator focused on the GSV trunk (30-40% of the CVD hemodynamic patterns).[8,9] Therefore, from this perspective, our herein proposed therapeutic option can't be dogmatically defined as a CHIVA procedure, but rather as an endovenous laser therapy to be performed according to CHIVA hemodynamic principles.

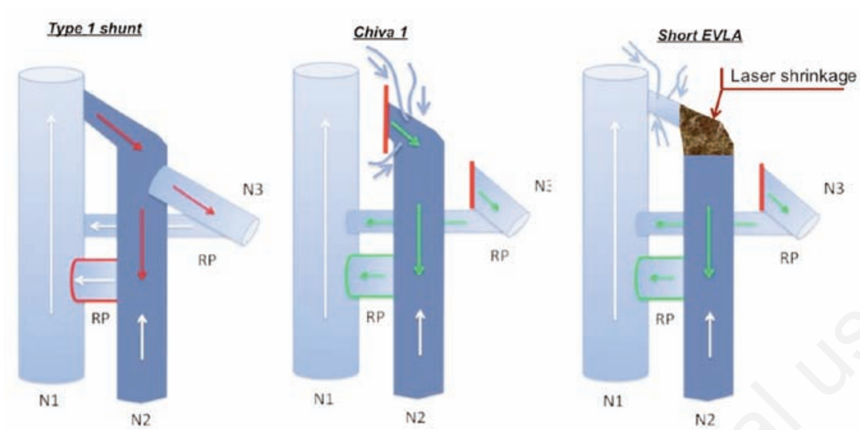

Figure 2. Type 1 + 2 shunt. Femoral vein (N1), great saphenous vein (N2), great saphenous vein (GSV) tributary (N3), and re-entry perforator (RP). In type 1 shunt there is a reflux constituting a pathological subversion of the physiological order of venous emptying (from the surface to the deepest compartment of the lower limb). The compartment jump (from N1 to N2) is fed by an incompetent sapheno-femoral junction. An additional compartment jump can be observed from N2 to N3 because of an incompetent tributary. A RP focused on the N2 compartment bring the shunted blood back to the N1 compartment. Pure hemodynamic correction (CHIVA) 1 strategy indicates the suppression of the pathological N1-N2 compartment jump thanks to a high tie with junctional collateral preservation. Segmental GSV shrinkage by endovenous laser ablation (EVLA) offers a N1-N2 jump suppression, but leaving a sapheno-femoral junction stump, where the junctional tributaries can drain.

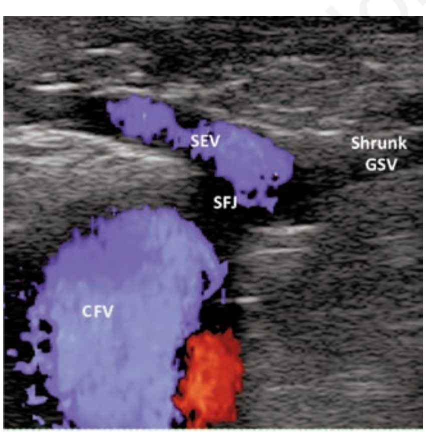

Figure 3. Case A outcome at 12 months follow up. The superficial epigastric vein (SEV) is draining into the sapheno-femoral junction (SFJ), while the great saphenous (GSV) trunk remained shrunk. CFV, femoral vein.

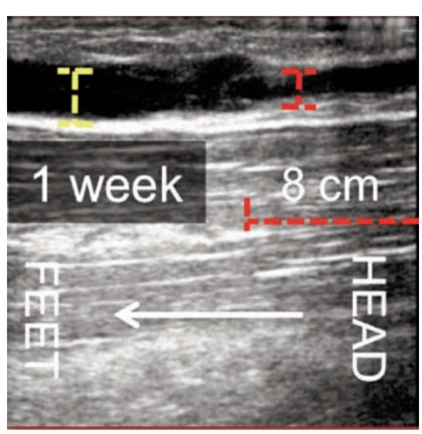

Figure 4. Case B wall thickening at the 1 week follow up echo-color-Doppler. The finding was extended from the distal great saphenous vein shrinkage for 8 cm downward.

The newly corrected flow pattern could provide a study model in the sapheno-femoral junction tributaries hemodynamic investigations, to be added to the ones that have been provided by past EVLA experiences.

More specifically, it would be possible to implement the data concerning the recurrence rates in case of junctional tributaries ablation versus conservation.[13]

In our Center, the idea of combining the EL technique with the CHIVA strategy was conceived in order to melt together EVLA mini-invasiveness with the hemodynamic correction long term efficacy.

We can postulate that a less aggressive sapheno-femoral confluence treatment could reduce the recurrence risk.[14]

The successful outcome of the first 2 cases paves the way for an even greater diffusion of the laser technology, together with all the other minimally invasive techniques that are able to produce a subinguinal GSV occlusion (laser, radiofrequency, steam, glue mechanical). This new technologies innovative application could increase the interest toward hemodynamic saphenous-sparing strategies also in the non-surgical physicians.[15]

Of course, this therapeutic option eliminates the requirements for surgical skill of traditional hemodynamic correction, but at the same time it forces all the involved physicians to possess an advanced sonographic knowledge.

Future randomized comparative trials among the proposed strategy, pure CHIVA and traditional EVLA could provide answers to the following questions:

- What is the hemodynamic role of the aspirating re-entry perforator in comparison to the GSV tributaries along the trunk in the draining maintenance?
- What is the minimum shrinkage length for a long-lasting sapheno-femoral occlusion?
- What is the most appropriate energy delivery setting?
- What are the hemodynamic parameters indicating a possible hemodynamic correction by EL?
- What are the hemodynamic features of the sapheno-femoral confluence to be assessed before an endovenous CHIVA planning?

Conclusions

Use of saphenous-sparing EL use seems to constitute an innovative and effective CVD therapeutic option. At the same time, it increases the potential efficacy of the not-surgical medical operators, and it forces all the involved physician into a deeper knowledge of the venous hemodynamics.

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Conclusive note

The resistance index (ore resistive index or Pourcelo index) is a hemodynamic parameter reflecting the resistance to blood flow. It is also related to the vascular compliance and is obtained by the following formula:

[(Peak systolic velocity - end diastolic velocity)/Peak systolic velocity, RI]

Practically, this represents a Doppler method to extrapolate an impedance parameter, expressing with a number the bi-directional flow and energy dissipation of the reflux phenomenon.

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