Hemodynamic patterns of reflux in primary sapheno-popliteal junction incompetence

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Abstract

Duplex ultrasound investigation (DUI) has considerably improved the diagnosis of anatomical venous variations in the popliteal region: however, some pitfalls still remain concerning the hemodynamics of incompetent sapheno-popliteal junctions (SPJs). Aims of this study were to assess the prevalence rates of the hemodynamic patterns of reflux, either diastolic or systolic or both, in a large series of patients with SPJ incompetence, and to analyze the origin of the systolic components of the reflux. Four hundred and fifty-three patients, 83 males and 370 females, mean age 58.0 years±SD 13.8 with primary SPJ incompetence (512 limbs) underwent preoperative DUI using the Paranà manoeuvre, a dynamic test able to develop systolic and diastolic pressure gradients through the reflex activation of muscle pumps. Of the 512 incompetent SPJs, 420 showed isolated diastolic reflux, 9 isolated systolic reflux and 83 systolic reflux followed by diastolic reflux. Altogether, 92 SPJs over 512 (18%) showed a systolic component of the reflux, which originated from the popliteal vein in 78 cases (15%) and from the gastrocnemius veins (GVs) in 14 cases (3%). In these latter cases, the short saphenous vein and one or more GVs showed a common trunk. Our findings show that the detection of a systolic component of the reflux in incompetent SPJs is not an uncommon event and suggest that treatment strategy should be differentiated according to the origin of the systolic reflux, given their different hemodynamic behavior.

Introduction

The outcome of short saphenous vein (SSV) surgery is often unsatisfactory owing to the higher complication and recurrence rates when compared to long saphenous vein surgery.[1-4] Standard surgical technique for the treatment of SSV varicose veins is based upon SSV ligation flush with the popliteal vein (PV) and subsequent SSV ablation.[5] However, one of the most frequently reported causes of recurrence is the failure to identify the sapheno-popliteal junction (SPJ),[1,2] and the more aggressive surgical dissection seeking for the SPJ, along with the anatomical complexity of the popliteal fossa, might be responsible for the higher complication rates. The reasons for the failure to locate and identify the SPJ are, probably, accounted for by the complex embryological development of the popliteal region that may lead to several anatomical venous variations.[6]

The widespread use of preoperative duplex ultrasound investigation (DUI) has considerably improved the diagnosis of the anatomical venous variations in the popliteal region:[6-8] however, some pitfalls still remain concerning the hemodynamic behavior of incompetent SPJs. In fact, in some patients with primary SPJ incompetence DUI shows a systolic component of the reflux, which occurs during muscle contraction.

In this study we systematically examined all incompetent SPJs by using the Paranà manoeuvre,[9] with the aim of assessing the prevalence rates of the hemodynamic patterns of reflux, either diastolic or systolic or both, in a large series of patients with incompetent SPJ and of analyzing the origin and the direction of the systolic component of the reflux.

Materials and Methods

Four hundred and fifty-three patients, 83 males and 370 females, mean age 58.0 years±SD 13.8 (min 19, max 89) underwent preoperative DUI on 512 incompetent SPJs. Patients with clinical history and/or instrumental findings suggesting previous deep venous thrombosis or primary deep vein incompetence were excluded from the study. According to the Clinical, Etiological, Anatomical, and Pathophysiological (CEAP) classification,[10] the characteristics of the study sample were: C=2-6s; E=p; A=s2-4, p17-18; P=r.

Ultrasound assessment was performed using a high-resolution duplex scanner (ESAOTE 'MyLab 50', Genoa, Italy, equipped with a 7.5-12 MHz linear phased-array and a 5-8 MHz micro-convex probe for imaging, with a 5 and 6.6 MHz Doppler, respectively, for flow analysis). In the course of the examination, we systematically performed the Paranà manoeuvre,[9] a dynamic test able to develop systolic and diastolic pressure gradients through the reflex activation of muscle pumps. Specifically the manoeuvre, which was proposed by Franceschi in 1997, consists in gently pushing from behind the patient in standing position to shift forward the center of gravity (Figure 1). This activates the proprioceptive reflex aimed at maintaining balance and the efferent arch of the reflex results in calf muscle contraction. Flow analysis was performed in both cross-sectional and longitudinal scans.

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Results

Of the 512 incompetent SPJs, 420 showed isolated diastolic reflux, 9 isolated systolic reflux and 83 systolic reflux followed by diastolic reflux. Altogether, 92 incompetent SPJs over 512 (18%) showed a systolic component of the reflux that originated from the PV in 78 cases (15%) (Figure 2A) and the gastrocnemius veins (GV) in 14 cases (3%). All the latter cases showed a common trunk formed by the SSV and one or more GVs s (Figure 2B).

Of the 78 cases of systolic component of the reflux originating from the PV, 75 were directed towards the Giacomini's vein (GiaV) (Figure 3A) and 3 towards the SSV (Figure 3B). In the 14 cases of systolic component of the reflux originating from the GVs, the reflux was directed towards the GiaV or the thigh extension of SSV (TE-SSV) and the physiological systolic forward flow of GVs directed towards the PV was always detectable (Figure 4).

Table 1 shows the overall distribution of the direction of the 512 refluxes that are schematically drawn in Figures 5-7.

In 10 of the 56 cases that showed a reflux directed towards the GiaV during the systole and towards the SSV during the diastole, the GiaV, along with the systolic ascending flow resulting from a systolic escape point, either the PV or the GVs, also showed a diastolic descending flow.

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Discussion

In this study we assessed the prevalence of the hemodynamic patterns of reflux in a large series of patients with incompetent SPJs and we found that a systolic component of the reflux was present in 18% of cases, suggesting that this is not an uncommon event.

Systolic components of the reflux in incompetent SPJs have already been reported by ourselves (European Venous Meeting, Faro, Portugal, 2000, unpublished data) and by Cavezzi *et al*.[11] However, in those studies the prevalence of the systolic component was considerably lower (9% and 6%, respectively) when compared to the prevalence found in this study (18%). With regard to our previous study, this discrepancy might be accounted for by the fact that the systolic component of the reflux originating from the GVs was not considered and that the Paranà manoeuvre was not performed systematically. In fact, dynamic tests, such as the Paranà manoeuvre, mobilize larger volumes of blood in the deep then in the superficial venous system. On the contrary, passive tests, such as the squeezing manoeuvre, mobilize larger volumes of blood in the superficial then in the deep venous system. As a consequence, the pressures developed in the deep venous system using dynamic tests are higher then those developed using passive tests.

In terms of general hemodynamics, a systolic component of the reflux is related to the development, during muscular contraction, of a pressure gradient directed from the deep to the superficial venous network. In the case of primary SPJ incompetence, *i.e.* without clinical or instrumental signs of previous deep venous thrombosis or of primary deep vein incompetence, the phasic systolic increase in the deep venous pressure may be related: i) either to the increased resistances to the physiological flow directed towards the heart, probably due to an *ab extrinseco* compression exerted by muscles and/or tendons somewhere along the course of proximal deep veins, or to the presence of small, or relatively small with regard to the flow,[12] popliteal and femoral veins; ii) or to anatomical geometrical characteristics of the junction, such as the size or the angle with respect to the popliteal vein axis.[13]

Based upon the above hemodynamic considerations, we can reasonably hypothesize that the systolic component of the reflux originating from the PV and directed towards the GiaV or the TE-SSV represents a derivative way aimed at by-passing the functional or anatomical obstruction of the physiological forward flow in the popliteal or femoral veins. Accordingly, this type of systolic reflux should not be interrupted as the suppression of a derivative way might expose the deep venous network to a hemodynamic derangement and, as a consequence, to

Table 1. Overall distribution of the direction of sapheno-popliteal junction refluxes.

Direction	Total	Systolic	Systo-diastolic	Diastolic
Short saphenous vein	413	2	1	410
Giacomini's vein	43	5	28	10
Giacomini's vein+ Short saphenous vein	56	56 (Giacomini's vein)	0	56 (Short saphenous vein)

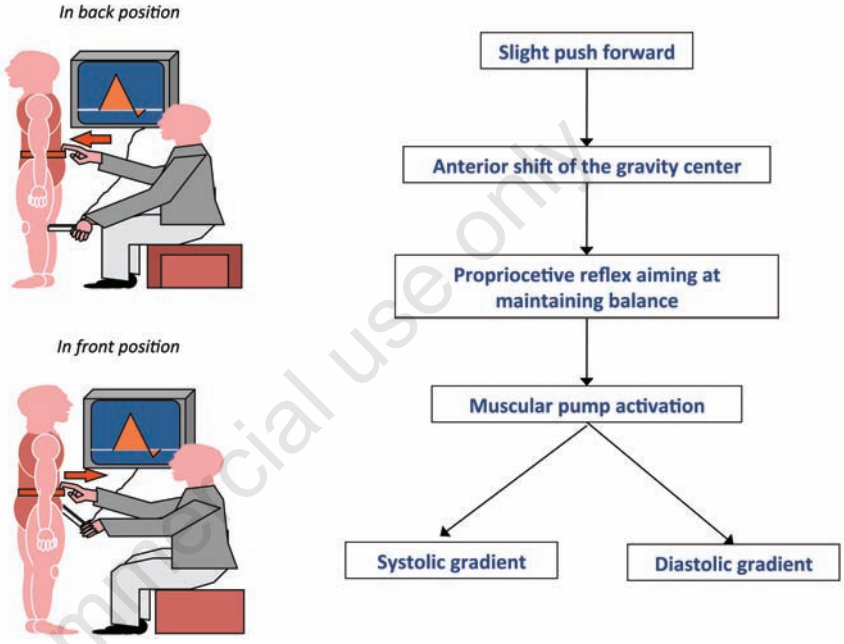

Figure 1. Parana manoeuvre (conceived by Claude Franceschi).

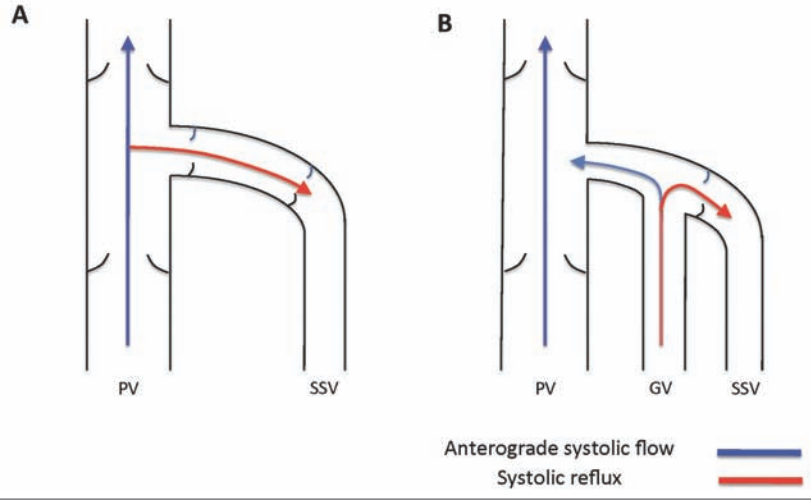

Figure 2. Origin of the systolic reflux.

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recurrent varicose veins. On the contrary, the systolic reflux originating from the GVs does not represent a derivative way, as documented by the detection in all these cases of the physiological flow directed from the GVs towards the PV. As we found in our series, the systolic reflux originating from the GVs was always directed towards the GiaV, suggesting that the anatomical characteristics of the junction, and in particular the *continuity* of the GVs with the GiaV, might account for the direction of the reflux towards the GiaV (Figure 8).

Before concluding, other findings of this study deserve some comments. First, with regard to the 56 cases that showed a systolic reflux directed towards the GiaV and a diastolic reflux directed towards the SSV, they raise the intriguing question of why the systolic reflux was not directed also towards the SSV, in spite of the clear-cut incompetence of SSV valves, documented by the diastolic SSV reflux. Actually, in all these cases we found a systolic anterograde flow in the SSV, originating from the foot muscular pump and from the fascial compression of the SSV, with consequent systolic increase in SSV pressure able to counteract the systolic reflux towards the SSV. Second, with regard to the 5 cases of isolated systolic reflux directed towards the GiaV, Pieri *et al.*[14] have suggested that the absence of a concomitant systolic reflux directed towards the SSV might be accounted for by the competence of proximal SSV valves, such as the pre-ostial valve. However, this explanation can be considered as satisfactory only in the cases in which the SSV does not show any systolic anterograde flow, while when the SSV shows a systolic anterograde flow, the absence of a systolic reflux directed towards the SSV is accounted for by the systolic anterograde flow itself, independent of SSV valve competence.

In conclusion, our findings show that the presence of a systolic reflux in incompetent SPJs is not an uncommon event and that the two types of systolic reflux show a different hemodynamics. Thus, the operational messages coming from this study are: i) in all cases of SPJ incompetence, the use of dynamic tests, such as the Paranà manoeuvre, to detect and characterize, by its origin and direction, any possible systolic reflux is strongly recommended; ii) surgical strategy for the treatment of incompetent SFJ should be differentiated based upon the hemodynamics.

However, future studies are needed to confirm our hypothesis on a broader scale and to verify through a randomized controlled trial whether hemodynamic-based surgery[15] on incompetent SPJ might lead to better results than established surgical technique. With regard to endovascular techniques, which always leave an open stump, they might be considered as an alternative approach for the treatment of SPJ incompetence limited to the

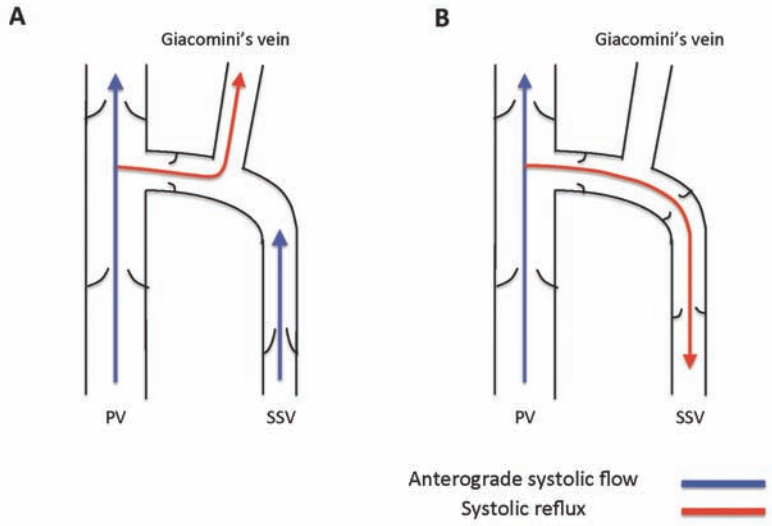

Figure 3. Superficial network involved by the systolic reflux originating from the popliteal vein.

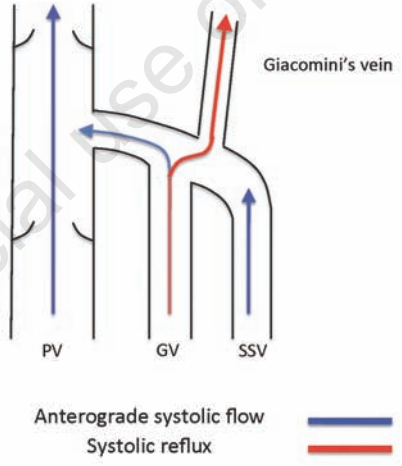

Figure 4. Superficial network involved by the systolic reflux coming from the gastrocnemius vein.

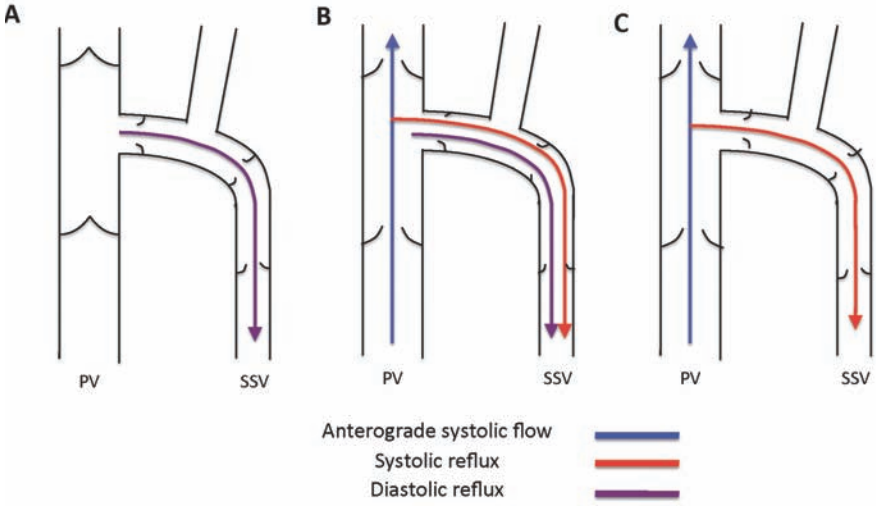

Figure 5. Refluxes in the short saphenous vein.

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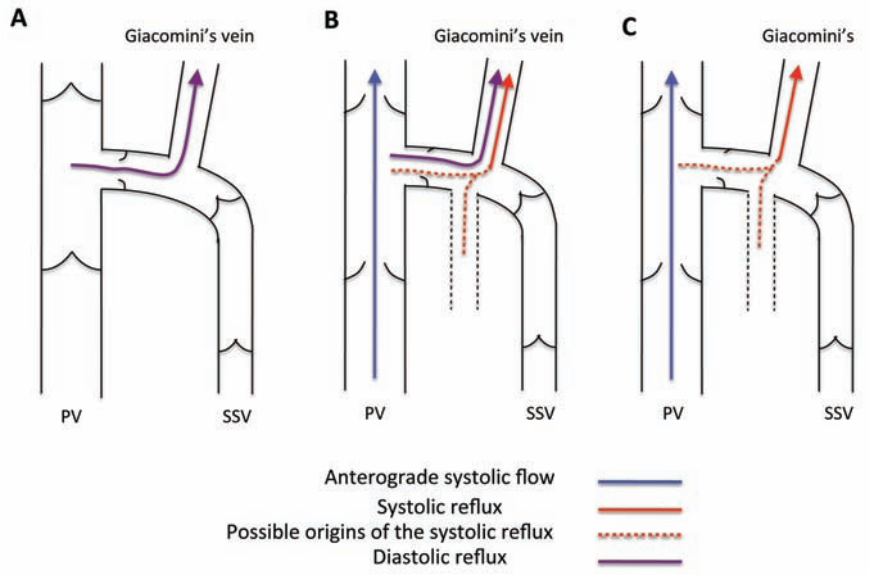

Figure 6. Refluxes only in the Giacomini's vein.

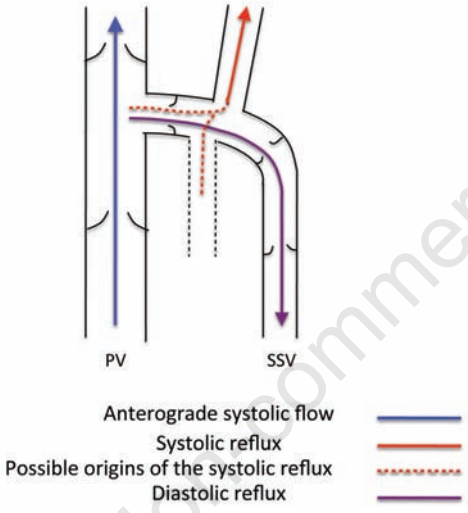

Figure 7. Refluxes in both Giacomini's and short saphenous vein.

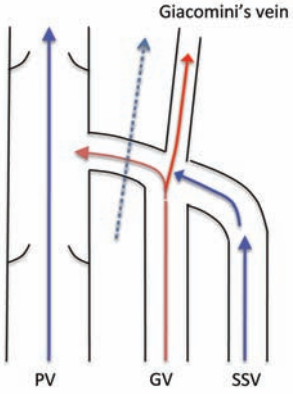

Figure 8. Angle between the grastrocnemius vein and the Giacomini's vein.

cases with systolic reflux and to those cases with diastolic reflux in which a big GiaV with descending flow or a common trunk formed by the SSV and one or more GVs warrant an optimal *wash out* of the stump able to prevent the leukocyte adhesion that triggers the inflammatory *cascade* leading to recurrences.

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