

The tenacious tendency to saphenous reflux recurrence and the possibility how to counteract it

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Abstract Varicose vein disease is characterized by a tenacious tendency to recurrence irrespective of the therapeutic method used; recurrent reflux is inextricably linked with recurrent varicose veins and is responsible for the progressive deterioration of the hemodynamic disorders. The hemodynamic preconditions for the development of recurrent reflux are generated during calf pump activity by the pathological drainage of venous blood from the incompetent thigh saphenous system into deep lower leg veins; the consequence is relocation of the dividing line of the ambulatory pressure gradient from below the knee joint where it is situated in healthy people into the thigh between the femoral vein and the incompetent thigh saphenous system, which sets off the chain of events producing recurrent reflux. This undesirable entanglement can be counteracted by interruption of the venous drainage at the level of the knee joint, where it is easiest and most effectively feasible. This can be achieved by surgical procedures, ablative methods or sclerotherapy. With reference to the behavior of pressure changes in deep and superficial veins of the lower extremity occurring during calf pump activity it can be deduced that external pressure of about 35 mm Hg applied just below the knee joint (e. g. by a rubber sleeve) might constitute an alternative therapeutic possibility; its effectiveness should be verified in clinical studies. If proved to be effective and tolerated by the patients, it would not only inhibit saphenous reflux in varicose vein disease but impede also the occurrence of hemodynamic preconditions responsible for the development of recurrent reflux.

Keywords recurrent reflux, external compression of the saphenous vein

Introduction

Varicose vein recurrences were reported to occur in a wide range up to 90% depending on the length of follow-up, the mode of therapy, and the method used to diagnose recurrence¹⁻⁵. Inadequate surgery leaving behind incompetent saphenofemoral junction with tributaries or incompetent trunk of the great saphenous vein in the thigh has been claimed to cause recurrence of saphenous reflux and varicose veins⁶⁻⁸. Nevertheless, recurrences occur also after correctly performed crossectomy and stripping⁹⁻¹¹. Even special measures, such as suturing the foramen ovale and inserting mechanical barriers over the saphenofemoral junction were not able to prevent recurrences¹²⁻¹⁸. Some authors expressed the opinion that recurrent reflux in varicose vein disease was unavoidable, no matter how careful the primary procedure was carried out, and postulated that the tendency of varicose veins to recur might be related to unspecified hemodynamic factors^{6, 19}.

This article mentions the hemodynamic phenomenon triggering recurrence of saphenous reflux and reflects on measures how to prevent it.

The tenacious tendency to generate recurrent reflux

Varicose vein disease has a tenacious tendency to recurrence, as documented in many papers¹⁻¹⁸. The progressively increasing intensity of recurrent saphenous reflux is responsible for the gradually deterioration of

the hemodynamic disturbance and the re-occurrence of chronic venous insufficiency. Nevertheless, in the course of the follow-up of 34 years, only 21.6% of limbs with recurrent reflux after primary surgery displayed congestive symptoms severe enough to necessitate reoperation¹¹.

Venous reflux is triggered by the ambulatory pressure gradient of 37.4 ± 6.4 mm Hg arising during calf pump activity between thigh veins with higher pressure and lower leg veins with lower pressure²⁰. Thus, the origin of reflux is situated always above the knee, the mouth/re-entry point below the knee. In primary varicose veins with impeccable competence of deep lower leg veins the calf perforators can never become the source of reflux because they are connected to the lower pole of the ambulatory pressure gradient. The dividing line of the ambulatory pressure gradient is situated in healthy people just below the knee joint at the beginning of the popliteal vein. Abolition of saphenous reflux in varicose vein disease eliminates the hemodynamic disturbance even in patients afflicted with the severest degree of chronic venous insufficiency and restores physiological hemodynamic values but, oddly enough, at the same time it generates preconditions for the development of reflux recurrence and for the progressive comeback of the previous pathological situation; this phenomenon has been called hemodynamic paradox²¹. The hemodynamic preconditions for reflux recurrence are induced during calf pump activity by the drainage of venous blood from the thigh saphenous system into the deep lower leg veins; the consequence is relocation of the dividing line of the ambulatory pressure gradient from below the knee into the thigh between the femoral vein and the incompetent thigh saphenous system. This situation triggers the chain of events engendering the occurrence of recurrent reflux: **pressure gradient** → increased flow through the tiny communicating vessels → increased fluid shear stress on the endothelium → release of vasoactive agents → progressive dilatation of the concerned vessels²²⁻²⁶. The relocation of the dividing line of the ambulatory pressure gradient is the characteristic feature of varicose vein disease; it does not arise in subjects with healthy venous system because competent valves preclude the drainage of venous blood from the thigh into the lower leg. Therefore, no pressure difference between the femoral vein and the superficial veins in the thigh can arise during calf pump activity in people with healthy veins, and no neovascularisation occurs after harvesting the great saphenous vein for bypass grafts

Measures counteracting the tenacious tendency to reflux recurrence

The problem-solving strategy is based on hindering the pathological drainage of venous blood from the incompetent thigh saphenous system into the deep lower leg

veins. This can be achieved either by invasive procedures or by conservative measures. During the surgical procedure, the easiest mode is precluding the drainage at the “strait”, i. e. at the knee level. All incompetent superficial veins must pass this bottleneck between the skin and the bones or muscles and are here easiest therapeutically assailable. Together with the abolition of saphenous reflux at the saphenofemoral junction all incompetent venous channels identified preoperatively by duplex ultrasonography should be interrupted in this bottleneck; the surgical procedure aiming at this goal has been published previously²⁷. Notwithstanding, new draining channels may develop in the course of follow-up; they should be checked at the knee level during the follow-up examinations and obliterated by sclerotherapy, if necessary.

Apart from the invasive procedures, a sheer conservative measure might produce similar beneficial hemodynamic results. Based on the behavior of pressure changes in deep and superficial veins of the lower extremity occurring during calf pump activity, it can be deduced that the same goal might be achieved by the external pressure applied in the form of a pneumatic cuff or a rubber sleeve closely below the knee joint. The pressure of about 35 mm Hg might be able to compress the saphenous system during the diastolic phase of the calf pump activity and impede in this way the saphenous reflux. It follows that it would

- 1. Hinder the diastolic saphenous reflux and the occurrence of ambulatory venous hypertension
- 2. Enable the physiological systolic centripetal flow
- 3. Hinder the pathological drainage from the thigh saphenous system into deep lower leg veins occurring during calf pump activity in the treated patients in whom saphenous reflux was abolished, and inhibit thereby the creation of preconditions triggering recurrent reflux.

As mentioned above, the saphenous reflux is triggered in the vertical/standing position by the ambulatory pressure gradient. During calf pump activity, the hydrostatic venous pressure decreases to about 25 mm Hg in the distal posterior tibial vein and to about 37 mm Hg in the great saphenous vein above the ankle; the diastolic pressure in the saphenous system closely below the knee may be still lower (it was apparently not measured directly). During calf muscle contractions the systolic pressure increases by roughly 35 mm Hg in the great saphenous vein above the ankle and by 50 mm Hg or more in the posterior tibial vein, so that the systolic centripetal flow toward the heart is guaranteed; external compression of about 35 mm Hg cannot hinder it. The Perthes test – applying a tourniquet in the thigh in order to compress the incompetent saphenous vein – documents that: the bulging varicose veins in the lower leg empty during calf pump activity. The pressure in the popliteal vein keeps the value of the hydrostatic pressure of 60 mm Hg; it displays small systolic and diastolic oscillations during calf

pump activity but does not decrease^{28, 29}. Adding up the ambulatory pressure (37 mm Hg) and the external pressure (35 mm Hg) yields the sum of 72 mm Hg, i.e. it exceeds slightly the pressure in the popliteal vein. Thus, the external pressure of 35 mm Hg would keep the dividing line of the ambulatory pressure gradient below the knee, as it is distinctive of healthy people.

This principle could set a new therapy modality in the treatment of varicose vein disease. It would be meritorious to verify this theoretical idea and specify the value of the external pressure necessary to achieve the designated aim.

Similar effect could be theoretically achieved by the so called hydrostatic therapeutic device consisting of a small sleeve of plastic material applied below the knee joint; the sleeve is connected to a small-caliber flat incompressible tube reaching into the axilla. If the whole device is filled with water, it exhibits in the standing position hydrostatic pressure of about 60 mm Hg below the knee joint; this pressure is able to effectively compress the saphenous system during the diastolic phase and hinder thereby the saphenous reflux taking place during the diastolic phase. Another advantage of this device – in contrast to the pneumatic cuff or rubber sleeve – is that the pressure in the hydrostatic device decreases in the sitting position and reaches near zero in the recumbent position.

Progressive elastic compression stockings

The effect of the so called progressive elastic compression stockings published by Mosti and Partsch³⁰ conforms to the same principle. The authors used plethysmography under a standardized walking test and reported that significantly better improvement of ejection fraction was found in patients with higher pressure over the calf than above the ankle, in comparison with conventional graduated pressure profile with higher pressure in the gaiter area and lower pressure in the calf. The progressive elastic compression stockings exerting compression pressure of 33 mm Hg in the gaiter area and 46 mm Hg at the calf level led to a pronounced improvement of the venous hemodynamics and returned the ejection fraction to or near the normal range.

Conclusion

Drainage of venous blood from the incompetent thigh saphenous system into deep lower leg veins arising during calf pump activity creates preconditions for the development of recurrent reflux and is responsible for the tenacious tendency to reflux recurrence. The interruption of this drainage would keep the dividing line of the ambulatory pressure gradient below the knee, as it is distinctive of subjects with healthy veins, and would hinder the emergence of recurrent reflux. This can be achieved by surgical procedures, ablative methods, and sclerotherapy.

Based on the results of the pressure measurements in superficial and deep veins of the lower extremity it can be deduced that external pressure of about 35 mm Hg applied closely below the knee joint would be able to inhibit saphenous reflux occurring in the diastolic phase of the calf pump activity and, in addition, antagonize the tenacious tendency to the development of recurrent reflux.

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