SciMedCentral

Annals of Vascular Medicine & Research

Short Communication

Hemodynamic Impact of Saphenous Reflux in Relation to Calf Pump Performance

Recek C*

Department of Surgery, University Hospital, Czech Republic

*Corresponding author

Recek C, Mantlergasse 24, 1130 Vienna, Austria, Email: cestmir@recek.at

Submitted: 24 February 2020

Accepted: 09 March 2020

Published: 13 March 2020

ISSN: 2378-9344

Keywords

• Saphenous reflux, Calf pump performance, Reflux volume

Abstract

Saphenous reflux is responsible for the hemodynamic disorders in patients with primary varicose veins. The actual undesirable impact depends on the reflux volume as well as on the performance ability of the calf pump expressed as ejected volume; these two factors work against each other. The deleterious effect of saphenous reflux can be mitigated by the compensatory increased performance of the calf pump. Both factors can be quantified using the parameter refill volume obtained by strain gauge plethysmography. The reflux volume can be computed by subtraction of the value of refill volume with reflux from the value of refill volume after abolition of reflux. The ejected volume is the volume that has been ejected during a series of calf muscle contraction; it matches with the value of the refill volume after abolition of saphenous reflux. The hemodynamic impact of saphenous reflux is expressed as a percentage indicating to which extent the saphenous reflux disturbs the efficiency of the calf pump using the formula: reflux volume divided by ejected volume X 100.

INTRODUCTION

Saphenous reflux is responsible for the hemodynamic disorders in patients with varicose vein disease. Nevertheless, the correlation between saphenous reflux intensity and the severity of clinical symptoms as expressed in the CEAP classification is poor [1]. This is because another factor – the performance of the calf pump is also involved in the process and influences the outcome [2]. The resulting hemodynamic disturbance is the consequence of the interplay of these two phenomena acting against each other: the calf pump performance and the reflux intensity.

Interaction of calf Pump performance and saphenous reflux intensity

The calf pump performance in primary varicose veins usually maintains its effectiveness; sometimes it can be even compensatory increased. This arises in a similar manner like in patients with atrial septal defect. Here the performance of the right ventricle is increased because it must pump into the pulmonary circulation, in addition to the cardiac output, the shunted volume coming through the open septal defect. In varicose vein patients, the calf pump must propel toward the heart, in addition to the normal circulating blood volume, the refluxing saphenous volume streaming through the incompetent saphenous vein and the calf perforators into the deep lower leg veins. The refluxing blood volume devalues the actual ***effective performance*** of the calf pump; the more intense the saphenous reflux, the more depressed the effective performance. If the volume of saphenous reflux equals to the ejected volume, the calf pump is not able to enforce the decrease in ambulatory pressure; the ejected volume is immediately replaced by the refluxing volume; the severest grade of chronic venous insufficiency is the consequence.

By means of strain gauge plethysmography it is possible to evaluate the interaction of saphenous reflux and calf muscle pump [3] and to quantify the resulting hemodynamic impact of saphenous reflux by expressing percentage-wise to which extend the saphenous reflux disturbs the calf pump efficiency.

Calculation of the hemodynamic impact of saphenous reflux

As mentioned above, two parameters must be assessed for this purpose:

1) The reflux volume, and

2) The ejected volume.

The reflux volume can be computed by subtraction of the value of refill volume with reflux from the value of refill volume after abolition of reflux. The ejected volume is the volume that has been ejected during a series of calf muscle contractions; it matches with the value of the refill volume after abolition of saphenous reflux. The hemodynamic impact of the saphenous reflux can be calculated from the formula: **reflux volume/ ejected volume x 100**

The proceeding is illustrated with the aid of (Figure 1 and 2) Strain gauge plethysmography was performed in two patients with reflux in the great saphenous vein. Left: situation with reflux, right: after abolition of saphenous reflux with a tourniquet applied in the thigh. The reflux intensity was nearly the same in both cases: in the first patient 0.8 ml/100 ml; in the second patient 0.9 ml/100 ml. Oddly enough, the hemodynamic effect of the almost equally severe saphenous reflux was quite different. In the first patient, the reflux volume of 0.8 ml/100 ml entailed nearly no decrease in the volume of the lower leg during the calf pump activity; the refill volume was just 0.1 ml/ 100 ml. By contrast, in the second patient the refill volume was nearly normal (0.6 ml/100 ml) in spite of the refluxing volume of 0.9 ml/100 ml. This was because the calf pump performance in the second patient was compensatory increased; it amounted to 1.5 ml/100 ml.

The computation:

In the first patient: saphenous reflux volume (refill volume after abolition of reflux minus refill volume with reflux) = 0.8 ml/100 ml. The ejected volume = 0.9 ml/100 ml (equals to the refill volume after abolition of reflux).

The hemodynamic impact of saphenous reflux: 0.8/0.9 x 100 = **88.8%**

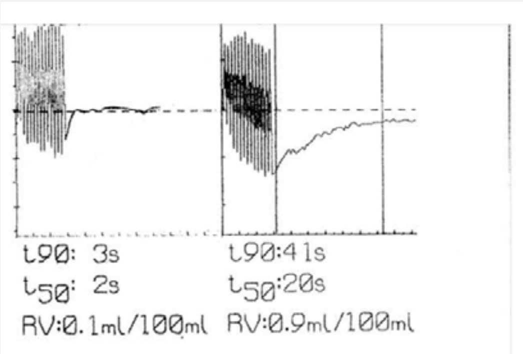

Figure 1 Strain gauge plethysmography in a patient with saphenous reflux. Left: with saphenous reflux. Right: after abolition of saphenous reflux by a tourniquet applied in the thigh. t 90, t 50 refill time, RV refill volume.

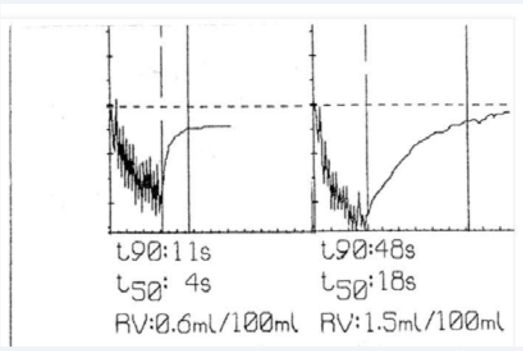

Figure 2 Strain gauge plethysmography in another patient with saphenous reflux and compensatory increased calf pump performance. Left: with saphenous reflux. Right: after abolition of saphenous reflux by a tourniquet applied in the thigh. t 90, t 50 refill time, RV refill volume.

In the second case: saphenous reflux volume = 0.9 ml/100 ml. The ejected volume = 1.5 ml/100 ml.

The hemodynamic impact of saphenous reflux: 0.9/1.5 x 100 = **60%.**

The hemodynamic impact of saphenous reflux can be also assessed in a similar way using the parameter residual volume gained by air plethysmography or by refill times when using e.g. the photoplethysmography. If refill times are used, the results would be as follows:

In the first patient: refill time t 90 after abolition of reflux = 41 s; refill time with reflux = 3 s. The difference is 38. The calculation: 38/41 x 100 = **92.6%.**

In the second patient: 48 – 11 = 37. The calculation: 37/48 x 100 = **77.1%**

The refill volume of 0.4 ml/100 ml gained by strain gauge plethysmography was found to represent the dividing line separating symptomatic and symptomless patients with 70.8% sensitivity and 62.5% specificity [4]. Patients with lower values tended to be symptomatic, patients with higher values tended to be symptomless. Because the lowest normal value of the refill volume is circa 0.8 ml/100 ml, the value of 0.4 ml/100 ml represents the half of the lowest normal value. It follows that the intensity of saphenous reflux provoking symptoms in varicose vein patients amounts to 50% or more of the ejected volume.

CONCLUSION

The hemodynamic disturbance in patients with primary varicose veins is the result of the interaction of two factors acting against each other: the calf pump performance and the saphenous reflux intensity. Using plethysmographic parameters refill volume, residual volume and/or refill time, the hemodynamic impact of the saphenous reflux can be calculated and quantified as a percental impairment of the calf pump performance, indicating in this way the effective calf pump performance in the given case. The compensatory increased calf pump effectiveness can mitigate the harmful effect of the saphenous reflux, as demonstrated on two cases with the same saphenous reflux intensity but differently effective calf pump performance.

REFERENCES

1. Mosti G. Iabichella ML, Picerni P, De Marco G. Quantification of venous reflux by means of some duplex scanner and light reflection rheography parameters and its correlation with chronic venous insufficiency symptoms. Minerva Cardioangiol. 2000; 48: 331-339.

2. Raju S, Ward M Jr, Jones TL. Quantifying saphenous reflux. J Vasc Surg Venous Lymphat Disord. 2015;3: 8-17.

3. Recek C. Quantification of saphenous reflux using the assessment of the refill volume [German]. Phlebologie. 1997; 26: 31-34.

4. Recek C. Medium-term results after crossectomy and sclerotherapy [German]. Phlebologie 2000; 29: 23-26.

Cite this article

Recek C (2020) Hemodynamic Impact of Saphenous Reflux in Relation to Calf Pump Performance. Ann Vasc Med Res 7(2): 1105.