Lowered Peripheral Resistance in Arteries of Legs with Venous Ulcer

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In the literature there is disagreement concerning the existence of arteriovenous shunting in legs with venous ulcer(s). The aim of this study was to find out if there are differences in resistance in the arteries of ulcer legs and non-ulcer legs and if it is possible to investigate this with a non-invasive Doppler method. Eleven patients, aged 34–87 years, with venous ulcer only in one leg, were investigated using angiography and duplex scanning. Angiography showed premature venous filling and Doppler examination showed lowered peripheral resistance in the arteries of every ulcer leg. Lowered peripheral resistance was found only in one non-ulcer leg, which, however, also had signs of venous stasis. Our results clearly show that there is lowered peripheral resistance in arteries of legs with venous stasis. The possible significance of this phenomenon in the pathogenesis of venous ulcer leg is discussed. Key words: Arteriovenous shunting; Duplex scanning.

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Angiography studies have shown premature venous filling in the lower extremities with varicosities, postthrombotic syndrome and venous leg ulcer (1–6). It has also been shown that the oxygen content is elevated in venous blood draining the legs with venous stasis (1–3, 7).

These findings have been suggested to be due to arteriovenous anastomoses (AVA) which have been opened due to venous stasis (1–5, 8–10).

However, there are also reports, based on labelled protein perfusion studies (11–13), in which the existence of AVA is challenged (14–16).

As there is disagreement in the literature and as we have also seen premature venous filling in angiography of the legs with venous ulcer, we investigated 11 patients with unilateral venous leg ulcer. The non-ulcer leg served thus as a control.

PATIENTS AND METHODS

Eleven patients (9 women, 2 men) with unilateral venous leg ulcer were investigated. The median age of patients was 64 years (range 34 to 87 years) and the median duration of ulcers 1 year 2 months (range 6 months to 14 years). Six of the patients had ulcer in the right leg and 5 in the left. Three patients had a history of previous deep venous thrombosis in the ulcer leg and 2 in the contralateral leg. Seven patients had a history of earlier ulcer in the ulcer leg and one in the non-ulcer leg.

The legs were inspected and palpated to reveal hyperpigmentation, swelling and induration (lipodermatosclerosis). By using a Kranzbuhler P280 continuous wave Doppler device (Squibb, Solingen, Germany) the competence of the valves of the femoral, popliteal and posterior tibial veins was investigated according to the method described by Sigel et al. (17). The ankle brachial systolic blood pressure index (ABI) was measured from dorsal pedal and posterior tibial arteries. ABI 1.0 or more was considered normal (18).

Ascending venography was performed to every ulcer leg and, because of leg edema, to two non-ulcer legs. Angiography was performed by injecting 50–60 ml of contrast medium (Iopamidol, Iopamiro, Astra-Medica, Molndal, Sweden) into the caudal part of abdominal aorta via a 6 F catheter introduced from common femoral artery. A moving examination table and a programmable film changer were used. The angiograms were read without knowledge of the clinical data. Because the angiograms of both legs are recorded on the same X-ray film simultaneously, it is possible to see if there is a difference between the legs concerning the phase of arterial and venous filling.

Using duplex method the arterial blood flow of popliteal, posterior tibial and dorsal pedal arteries of both legs of the recumbent patient was examined with Acuson 128 colour flow ultrasound scanner (1220 Charleston Road, Mountain View, Ca 94039, USA). Doppler spectra of each peripheral artery were recorded on hard copies. Lack of early diastolic retrograde flow and enhanced diastolic antegrade flow in Doppler examination were considered to mean lowered peripheral resistance. To obtain more objective quantitative information, resistance indices (Prouvost indices) of popliteal, dorsal pedal and posterior tibial arteries were calculated from Doppler waveforms (19). These calculations were made from the hard copies on a separate occasion without knowledge of the clinical data.

The median time interval between angiography and duplex-examinations was 2 days (range: on the same occasion to 14 months).

Statistics

Student’s paired t-test was used when comparing resistance indices between ulcer leg and non-ulcer leg.

RESULTS

Every ulcer leg was slightly to severely hyperpigmented, swollen and indurated, except one which was not swollen at the time of investigation. Reflux in deep veins was found in eight ulcer legs.

Ascending venography revealed incompetent perforator veins in ten ulcer legs. In one ulcer leg the popliteal vein was occluded (due to earlier surgical ligation) and there were abundant venous collaterals without evident incompetent perforator veins.

Reflux in deep veins was found in two non-ulcer legs. The

Table I. Mean resistance indices calculated from Doppler waveforms of peripheral arteries in 11 patients with unilateral venous leg ulcer

\begin{tabular}{|l|l|l|l|l|}
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\hline
& Non-ulcer leg & Ulcer leg & Difference & p-value \\
\hline
PA & 1.22 (0.16) & 0.98 (0.20) & 0.24 (0.18) & 0.12 to 0.36 & 0.0014 \\
PTA & 1.16 (0.19) & 0.88 (0.20) & 0.28 (0.22) & 0.12 to 0.44 & 0.0030 \\
DPA & 1.18 (0.22) & 1.05 (0.18) & 0.13 (0.20) & -0.01 to 0.28 & 0.6617 \\
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other had incompetent perforators in venography and ulcer previously. In addition one patient had incompetent perforators in venography of her non-ulcer leg.

ABI was 1.0 or more in both legs of 9 patients, while the 2 oldest patients had 0.8 and 0.9, respectively, in both legs due to concomitant occlusive arterial disease.

In every ulcer leg angiography revealed premature venous filling. In 3 patients local arteriovenous anastomoses could be seen, whereas in the others the shunting was more diffuse.

In every ulcer leg the Doppler examination showed lowered peripheral resistance in one to three arteries. Also in one non-ulcer leg there was lowered peripheral resistance (in dorsal pedal artery) but no evidence of premature venous filling in angiography, performed 2 days later. In this leg the great
saphenous vein had been stripped earlier and the leg was hyper-
pigmented and slightly swollen.

Peripheral resistance obtained from Doppler waveforms was
lower in ulcer legs compared with non-ulcer legs. Calculated
resistance indices (Pourcelot indices) are presented in Table 1.
The difference is statistically significant concerning popliteal
and posterior tibial arteries.

The findings in duplex scanning and angiography of one
patient are indicated in Fig. 1a–c.

DISCUSSION

Based on our findings, duplex scanning seems to offer a suitable
non-invasive method of studying the peripheral resistance in
arteries of legs with venous stasis.

We found premature venous filling in angiography and
lowered peripheral resistance in duplex scanning in all the legs
with venous ulcer.

In previous literature premature venous filling in angiography
has been considered to be due to AVA which have been opened
because of elevated venous pressure and elevated tissue resis-
tance (1–5, 10). According to this it has been observed that
there is elevated oxygen content in venous blood draining a leg
with venous stasis (1–3, 7). Furthermore, increased blood flow
in skin of legs with chronic venous insufficiency has been
observed (20, 21). With the methods we used, it is not possible
to show directly the existence of AVA, but the findings of
capillary underperfusion in skin of legs with venous stasis (22)
suggest that the lowered peripheral resistance in arteries is not
due to inflammatory capillary dilatation.

In one non-ulcer leg the peripheral resistance was lowered in
the dorsal pedal artery, whereas angiography did not show
premature venous filling 2 days later. Also in this non-ulcer leg
there was evidence of venous stasis. The discrepancy between
the results of angiography and Doppler examinations in this
non-ulcer leg can be supposed to be due to the existence of AVA
which can open or close as overflow channels depending on the
degree of elevated venous pressure and tissue resistance (2–4,
10, 23). This may also explain why compression therapy is so
advantageous in the therapy of venous leg ulcers.

Based on the findings in isotope studies (11–13) the existence
of AVA has been challenged (14–16). Those studies have, how-
ever, been carried out without correlation to angiography. De-
spite of their criticism against AVA, Dodd et al. (15) observed
lowered skin oxygen tension and Partsch (16, 20) also found
increased skin blood flow in legs with venous ulcer. Both
phenomena can be explained by arteriovenous shunting.

Partsch (16) has suggested that albumin acts like fibrinogen
and deposes pericapillary in postthrombotic legs. This may
explain why labelled albumin can accumulate near the ulcer
(11). Thus, isotope studies may be misleading in their
attempts to examine arteriovenous shunting in legs with venous
stasis.

Our results suggest that the elevated venous pressure and
tissue resistance cause arteriovenous shunting leading to
hypoxia in skin, and, if severe enough, to susceptibility to ulcer
formation. It may also impair healing of the formed ulcer.

further studies are, however, needed to clarify the real sig-
nificance of this phenomenon in the pathogenesis and healing of
venous leg ulcers.

REFERENCES

   Angiologie 1953; 4: 59–100.
   physio-pathologique des causses de dervation arterio-veineuse, dits
   de secupat, dans certaines affections vasculaires. Lyon Chir 1954;
3. Fontaine R. The John Howans Memorial lecture. Remarks concern-
   anastomoses in vascular diseases of the lower extremity. Ann Surg
   1966; 164: 990–1002.
5. Welbourn E. The value of radiological investigation of chronic
6. Schalin L. Arteriovenous communication to varicose veins in the
   lower extremities studied by dynamic angiography. Acta Chir Scand
8. Holling HE, Beecher HK, Limton RR. Study of the tendency to
edema formation associated with incompetence of the valves of the
   communicating veins of the leg. Oxygen tension of the blood
   456–460.
10. Antal SC, Reiss R. Post-thrombotic leg ulcer and its surgical
11. Lofferr A, Mousteck A, Partsch H. Untersuchung zur Gefaess-
    regulierung der Extremitaten mit besonderer Berucksichtigung
    arteriovenoser Shunts. Strahlentherapie – Strahlentherapie 1968;
    67: 454–460.
    arteriovenoser Anastomosen bei der primaren Varicosis und der
15. Dodd HJ, Gaylarde PM, Sarkany I. Skin oxygen tension in venous
    for diagnosing lower extremity venous disease. Surg Gynec Obstet
18. Carter SA. Indirect systolic pressures and pulse waves in arterial
    occlusive disease of the lower extremities. Circulation 1968;
    37: 624–637.
19. Planifol FH, Pourcelot L. Doppler effect study of the carotid circula-
    tion. In: Vlieger M, White DN,McCreedy VR, eds. Ultrasonic
20. Partsch H. Hyperaemic hypoxia in venous ulceration. Br J Derma-
22. Luetolf O, Bull RH, Bates DO, Mortimer PS. Capillary under-
    perfusion in chronic venous insufficiency: a cause of leg ulcer-
23. Ryan TJ. The epidemis and its blood supply in venous disorders of
    the leg. Transactions of St John’s Hospital Dermatological Society