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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 leg ulcer 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 P 280 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-Meditec, Mölndal, 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 (Pourcelot 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*

PA = popliteal artery; PTA = posterior tibial artery; DPA = dorsal pedal artery.

	Non-ulcer leg	Ulcer leg	Difference		*p*-value
	Mean (SD)	Mean (SD)	Mean (SD)	95% CI	
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	0.0617

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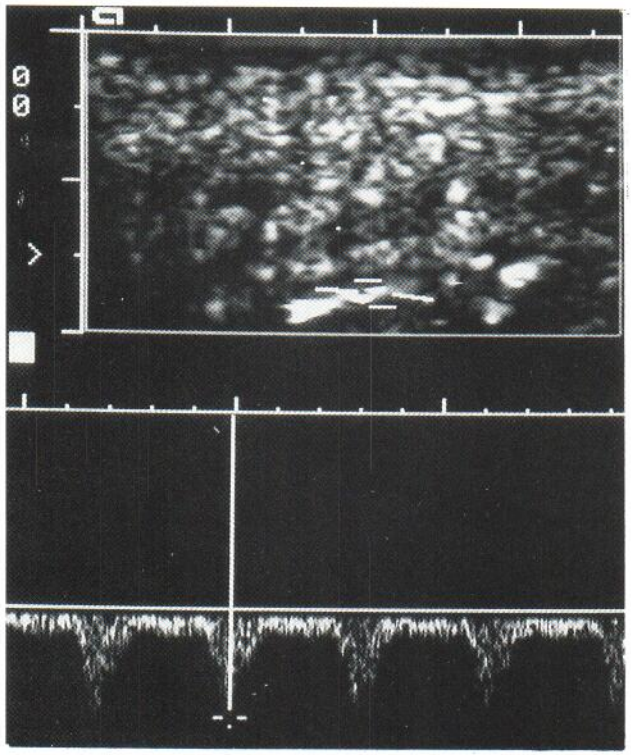

Fig. 1a.

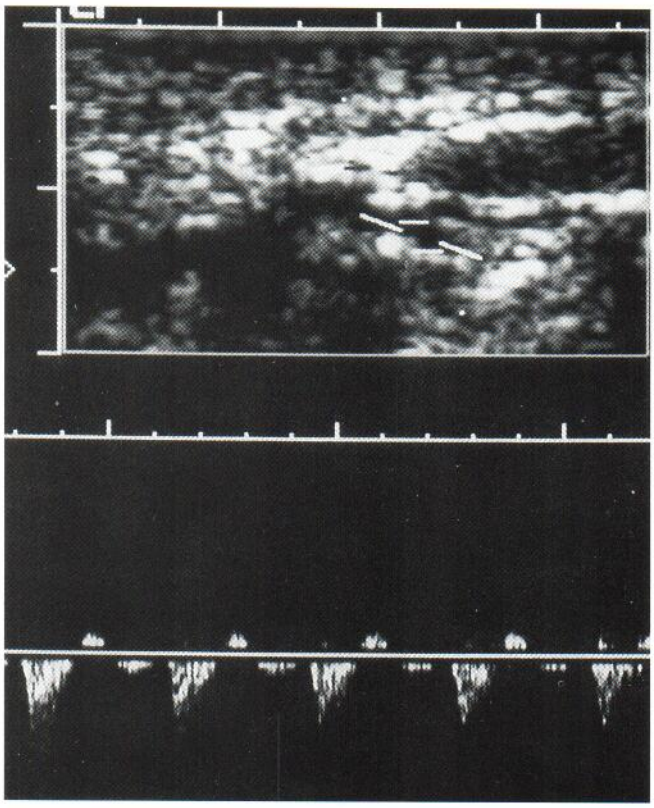

Fig. 1b.

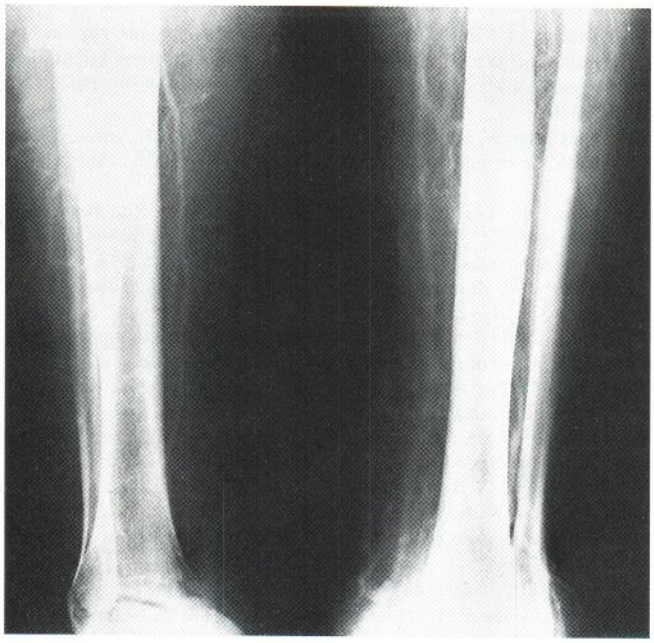

Fig. 1c.

Fig. 1. (a) A 34-year-old woman who has chronic venous ulcer in her left leg. Duplex scan of the left posterior tibial artery. Doppler waveform indicates lowered peripheral resistance (lack of reverse flow component in early diastole and abundant antegrade diastolic flow). *(b)* Duplex scan of the same artery of contralateral, healthy leg. Normal triphasic Doppler waveform. *(c)* Angiogram of both lower extremities of the same patient. Premature venous filling is seen on the left side compared to the right. Contrast material can still be seen in the arteries of the right leg.

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 hyperpigmented 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 I. 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 resistance (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, however, been carried out without correlation to angiography. Despite 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 pericapillarly in postthrombotic legs. This may explain why labelled albumin can accumulate near the ulcer (11). Thus, radioisotope 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 significance of this phenomenon in the pathogenesis and healing of venous leg ulcers.

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