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"Communicating Lymphatics" and Lympho-Venous Communications in Relation to Deep Venous Occlusion of the Leg

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Dilatation (ectasia) of the subcutaneous lymphatics and opening up of new lymphatic channels were observed in cases of swollen legs due to deep venous thrombosis of the calf – (Fig. 1) (9, 1, 7). The severer the degree of deep venous occlusion, the more the subcutaneous lymphatics were found to dilate and the more channels to open-up, denoting a direct relationship between the flow of lymph in the subcutaneous lymphatics and the increased venous tension within the musculo-fascial compartment of the leg (3). This points to the existence of some form of mechanism whereby the effects of such an intrafascial deep venous hypertension could be transmitted to the subcutaneous lymphatics across the tough deep fascia of the leg. The following suggestions were put forward for the explanation of such a mechanism:

1. In deep venous hypertension of the calf, the high pressure in the deep veins is "blown-out" into the subcutaneous veins (5). With an increased pressure in the subcutaneous veins, a decreased uptake of normal capillary effusion with an increased tissue pressure would result in the formation of excessive amounts of tissue fluids which, in turn, throws an increased load on the subcutaneous lymphatics.

2. The possible existence in the leg of lymph vessels, which cross the deep fascia, similar to communicating veins. These may help to drain tissue fluids from within the deep fascia outwards into the subcutaneous lymphatics.

3. The possible existence in the leg of functioning lympho-venous communications which could transmit the increased venous tension directly to the subcutaneous lymphatic trunks.

This article embodies a histological and an anatomical search for lymph vessels which traverse the fascia cruris and for lympho-venous communications, as well as an attempt at the assessment of the direction of flow of lymph in the deep and subcutaneous tissues of the human leg.

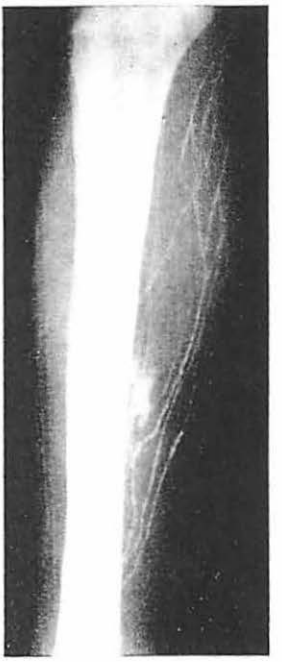

Fig. 1 Lymphangiogram of a case of deep venous thrombosis showing the "saphena-media" group of lymph vessels dilated and increased in number. There is some filling of the lymphatics on the outer aspect of the leg. A pool of contrast material is seen opposite the middle of the tibial shaft, which suggested a lymphatico-venous communication into a subcutaneous varix.

Material and methods

The material for this study consisted of:

A. Histologic material of normal deep fascia and communicating veins of the leg: specimens of communicating veins with a surrounding area of deep fascia were obtained from 5 fresh post-mortem cadavres dying in accidents and having no evidence of disease in their legs. Serial transverse paraffin sections, 5 microns thick, stained with haematoxylin and eosin, were examined (2).

B. Above knee amputation specimen, where the lymphatics were rendered visible by the injection of dye, in vivo, 20 minutes prior to operation. Twenty such specimens were collected and classified into 3 groups:

1. The first group consisted of 5 specimens, the dye used being a solution of "patent blue", injected into the webs aiming at the coloration of the superficial lymphatics (10).

2. The second group consisted of 10 specimens. The same dye was used. The injection was given deep into the sole of the foot, aiming to fill the subcutaneous lymphatics from a deep lymphatic injection.

3. The third group consisted of 5 specimens in which patent blue was injected into the webs and another dye "Indigo-carmine", was injected deep into the soft tissues of the sole of the foot.

The amputated limbs were taken immediately after operation, perfused through the stump of the femoral vessel with a solution of 1% carbolic in 5% formalin. Dissection of the limb was carried out 24 hours later, the tissues having been sufficiently hardened and the bad odour avoided.

Results

A. *Histological Findings:*

In transverse sections of communicating veins in the lower half of the leg, a lymph vessel could be repeatedly seen to accompany some of the communicating veins, particularly in the region of the ankle perforators. A communicating vein could be seen accompanying an arterial twig with a small lymphatic in-between (Fig. 2).

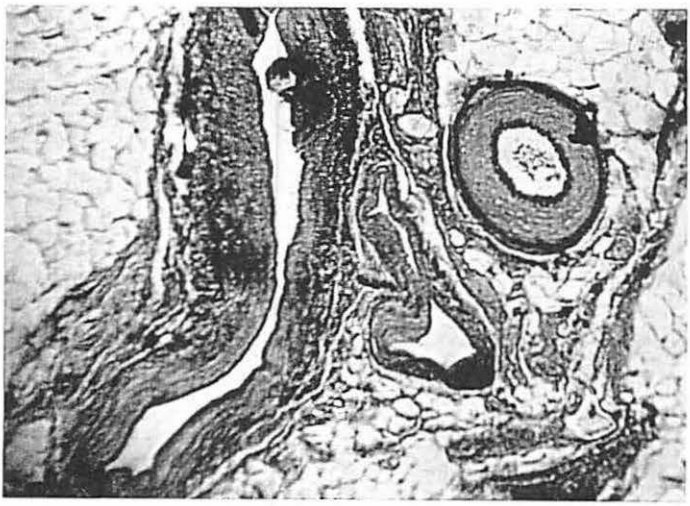

Fig. 2 Transverse histological section of communicating vein. A lymph vessel is located between the artery and the vein.

B. Anatomical Findings:

1. In all the five specimens (group I), the subcutaneous lymphatics of the leg and foot took up the dye.

2. In six out of the 10 specimens "group 2", patent blue injected deep into the sole of the foot, the dye was seen in the subcutaneous lymphatics. In the remaining 4 specimens the subcutaneous lymphatics were not visualised.

In 4 out of the six specimens, where the subcutaneous lymphatics were visulised, the coloration of these lymphatics was seen only above the ankle, starting from the lower third of the leg upwards. In the remaining two specimens, the subcutaneous lymphatics of the foot as well as those of the leg, took up the dye.

3. In the 5 specimens of group 3 where patent blue was injected into the webs and Indigo-carmine injected deep into the sole of the foot, the results were not conclusive. The visualisation of the subcutaneous lymphatics was possible after being coloured with patent blue. On opening the deep fascia of the leg, an unavoidable damage to the delicate lymph trunks occured which resulted in a rather messy diffusion of colours rendering a satisfactory differentiation between the two impossible.

These specimens were added to group I.

4. In 2 out of the 10 specimens (group 1 and 3) direct lymphovenous communications were demonstrable. In one specimen (an above-knee amputation for a bone sarcoma of the upper end of tibia in a 12 year old boy) a tiny lymph vessel was seen to arise

from one of the lymph trunks of the saphena media group and join the long saphenous vein at its junction with a communicating vein at mid-leg (Fig. 3, 4 and 5).

Fig. 3 Dissection specimen showing subcutaneous veins and lymphatics.

Fig. 4 Close up view of specimen shown in Fig. 3.

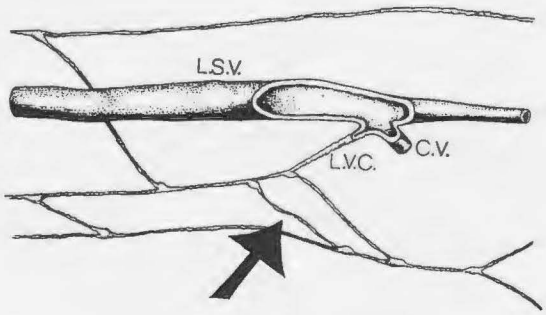

Fig. 5 A drawing from Fig. 4: "L.S.V." long saphenous vein, "C.V." communicating vein and "L.V.C." the Lympho-venous communication.

In the second specimen, (a diabetic leg of a 48-year old man) again a tiny lymph vessel was seen arising from one of the trunks of the saphena media group and joining one limb of a duplicated long saphenous vein at the junction of the lower and middle thirds of the leg.

Discussion

Communicating Lymphatics:

An adequate information about lymphatics crossing the deep fascia, similar to communicating veins was scarce in the literature. The visualisation in serial sections of a cross section of a lymphatic side by side to a cross section of a communicating vein demonstrates their existence. Though the attempts at the determination of the direction of flow of lymph in these communicating lymphatics were not conclusive; yet evidence suggests that such a flow occurs from within outwards.

The appearence of the dye in the superficial lymphatics above the ankle after a deep injection into the sole strongly suggests that the dye has reached subcutaneous lymphatics via these lymphatics. The term communicating lymphatics is suggested for these lymphatics.

The appearence of the dye simultaneously in the foot and leg in the other two cases could be accounted for by:

a) dye leaking into the subcutaneous tissues.

b) the possible existence of similar "communicating" lymphatics in the foot as well.

The attempt at a contrast coloration of superficial versus deep lymphatics of the leg was not conclusive. The quick diffusion of the dye and the messy admixture of the colours warrants an attempt at the use of a coagulable medium for the dye which could be safely injected in vivo.

In deep venous occlusion, the increased tissue fluid and excessive protein leak taking place from the engorged deep and muscular veins could find an exit to the superficial lymphatics across the deep fascia of the leg (presumably) through these "communicating" lymphatics. The slimming of swollen legs due to deep venous occlusion, after elevation seems to be largely achieved by the subcutaneous lymphatics in this same way.

Lympho-venous shunts:

It is generally agreed that the main lympho-venous communication is from the thoracic duct to the left jugular vein at the root of the neck. Other anastomoses were recorded in monkies (17), rats (8), cats (11), dogs (4) as well as in man (14). They were observed mainly in the abdomen at the level of the renal veins. Lympho-venous communications in other situations were noted in advanced malignant disease (18).

The anatomical and physiological evidence for the existence of lympho-venous communications in the leg was reviewed by *Rusznyak* (16) who concluded that though such shunts may be demonstrable anatomically, yet they are functionally negligible under normal circumstances.

Patterson (12) could only demonstrate negligible shunts at the sites of the lymph nodes. Their existence in hind limbs of dogs was further emphasized by *Pentecost* (13). Most of the material reported in previous studies consisted of experimental animals and post-mortem human studies where conditions may not be similar to the normal human. The material here presented consists of human lower extremities where the lymphatic injection with the colouring dye was done in vivo. The aim was to guard against any distortion in the anatomical appearance of the lymph vessels which may take place as a result of the forcible massage trying to force the dye into the lymphatics in post-mortem studies. The demonstration of lympho-venous communications in 2 out of 10 specimens studied in this work, emphasises their existence in the human leg.

Though the precise mechanism for inducing function of lympho-venous communications is not yet established, some factors were stated to facilitate the demonstration of these communications. *Pentecost* (13) has shown that such communications become functionally significant after the ligation of all the lymphatics in the hind limb of dogs. An increased incidence of demonstrated lympho-venous shunts in the human was noticed in certain diseased states such as renal and hepatic disease as well as congestive heart failure (16, 6, 15, 18, 19). Also lympho-venous communications were demonstrable in conditions with extracellular fluid accumulation (19).

Fig. 6 Cuticular hair type of varix (female aged 47 years).

The relation of lympho-venous communications to chronic venous hypertension in the leg seems to have attracted little attention. In chronic venous hypertension most of the factors known to favour the functioning of lympho-venous communications are present. The pool of the dye frequently seen escaping from one of the lymphatic trunks, in lymphangiograms of swollen legs due to deep venous thrombosis, strongly supports the assumption that lympho-venous communications become functionally active in these cases. As a matter of fact, this observation was more pronounced in lymphangiograms where an aqueous radio-opaque medium was used, and a mild venous tourniquett applied to the thigh (Fig. 1).

Studies on the lymphatic flow in the lower limb in cases of deep venous thrombosis of the leg by radio-active isotopes are still in progress. The results obtained, so far,

have shown a marked reduction in the web to femoral vein time in these cases. A detailed report on this work will be issued in a later report.

Fig. 7 Microphotograph (High Power) of the same case (Fig. 6) showing the dilated dermal "lymph vessel".

The presence in the leg of such lympho-venous communications can provide an explanation for the frequent occurrence of phlebitis and thrombosis of the deep veins of the leg in patients having septic foci between their toes. A free passage is available for the infection to get from the webs to the veins of the calf. The spread of infection from the foot to the calf, in diabetic legs may also follow the same route.

A reversed veno-lymphatic flow through such communications may also take place in deep venous occlusion of the leg. As the communicating veins become forcibly dilated under the effect of the deep venous hypertension it is quite possible that lympho-venous shunts open up and allow the blood to flow from the vein back into the lymphatic. The aetiology of varicose pigmentation and eczema are being considered on the basis of this assumption.

The relation of lympho-venous communications to varicose vein diseases of the lower limb as a whole is being investigated. Cuticular hair types and spider web varices are being studied on the basis of being superficial cuticular lymphatics filled with blood via lympho-venous communications (Figs. 6 and 7). The frequent appearance of these types of varices in menopausal women suggests a possible hormonal effect on such communications.

Summary

Histological studies of communicating veins and deep fascia of the leg revealed lymphatics to accompany the communicating veins in their journey across the deep fascia. Evidence obtained from anatomical studies of amputation specimens where a dye was injected in vivo suggests that the flow of lymph in these channels occurs from within outwards. The name "communicating lymphatics" was suggested for these channels.

The significance of these "communicating lymphatics" in deep venous occlusion of the leg is discussed.

Dissection of amputated legs injected with a dye in vivo also revealed lympho-venous communications. A discussion on lympho-venous communications and their possible relation to deep venous occlusion is given.

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The Treatment of Acute Lymphoedema with Pantothenic Acid and Pyridoxine:

An electron microscopical investigation

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Lymphoedema which is caused by impedance of lymph outflow from a region, is becoming recognised as the origin, or a contributing factor of many diseases. It has been shown that surgical obstruction of the cervical lymphatics results in *Lymphostatic Encephalopathy*. This is characterised by striking central nervous signs and a series of morphological alterations in the brain and the eye, accompanied by a lymphoedema of the muzzle (1–8). Surprisingly, it was found that these signs and alterations can be largely and safely prevented by treatment with high doses of Pantothenic acid and Pyridoxine (9, 10). This has been established in a number of species, including the rat, the dog and man.

The electron microscope was used to help investigate how this treatment works. Observations were made on the lymphatics in the tongues of normal rats, of some whose cervical lymphatics had been ligated, and of others with a similar operation but with the treatment as well. The tongue was chosen since it is drained by the same