

# VENOUS STASIS AND THE STATE OF THE MICROCIRCULATION IN SYNOVIAL MEMBRANES

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The state of the microcirculation of the synovial membranes in venous stasis was investigated in dogs. After ligation of the femoral vein disturbance of the blood flow leads to changes in the microcirculation in the synovial membranes and to congestion of the venules. Thinning of the capillary walls and the formation of swellings and protrusions are observed. The severity of the changes in the vessel wall depends on the caliber of the vessels. One month after ligation of the vein, the signs of stasis in the tissues of the articular capsule are reduced, indicating the development of a collateral venous circulation.

**KEY WORDS:** Venous stasis; microcirculation; synovial membranes.

Despite many investigations of the venous circulation of the limbs [1-3, 5, 6] none have been devoted to the characteristics of the vessel walls in the synovial membranes during a disturbance of the venous drainage from the soft tissues.

The present investigation was carried out for this purpose.

## EXPERIMENTAL METHOD

Experiments were carried out on 32 dogs. Venous stasis was produced in the right hind limb by ligation of the femoral vein below the level of reception of the great saphenous vein. The animals were killed 6 h and 1, 6, and 32 days after the operations. The microcirculation of the synovial membranes of the knee joint and tendons of the long muscles of the calf in the fibro-osseous canal were investigated. Blood vessels of the left hind limb served as the control. The material was stained with silver nitrate by Kupriyanov's method [4].

## EXPERIMENTAL RESULTS

Ligation of the femoral vein did not lead to complete cessation of the venous outflow, for the superficial veins of the limb partly compensate for the disturbed blood flow along the deep veins. The congestion of the subcutaneous veins developing under these conditions can be seen by simple external inspection of the limb. The pattern of the venous network on the thigh and leg was sharply defined; varices and communications between the deep and superficial veins, filled with blood, could be seen.

In total preparations of the synovial membranes a dense network of vessels was revealed. The constricted arterioles were lost among the dilated capillaries, postcapillaries, and venules (Fig. 1). The outlines of the vessels of the venous part of the microcirculation were indistinct. The density of the vascular network was sharply increased on account of the increase of the diameter of the postcapillary venules and all the reserve capillaries.

By photography under high power of the microscope the vessels of the synovial sheath and synovial membrane showed evidence of venous stasis (Fig. 2). The collecting venules were distended with blood.

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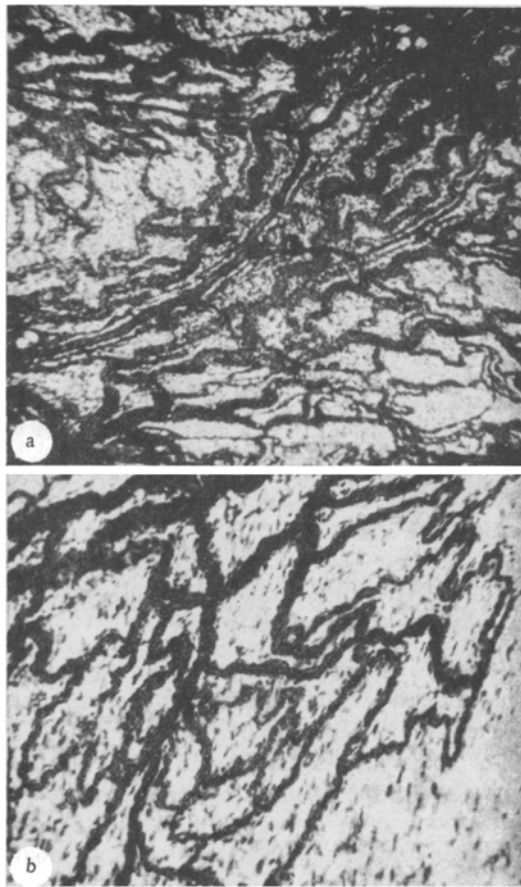


Fig. 1. Vascular network of synovial sheath of a muscle tendon from the dog hind limb: a) experiment (flexor hallucis longus); b) control (extensor digitorum communis). Impregnated with silver by Kupriyanov's method (24.5  $\times$ ).

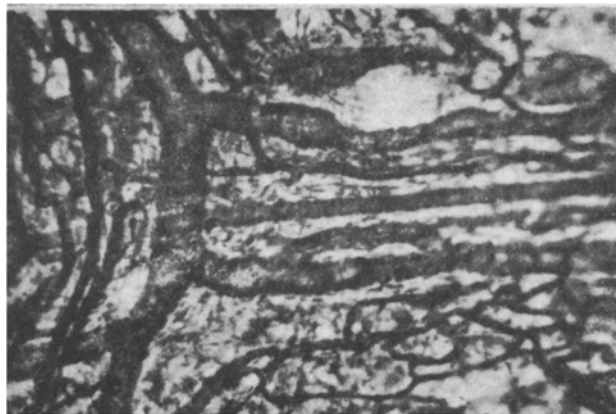


Fig. 2. Fragment of vascular network of synovial sheath of tendon of extensor digitorum communis in a dog. Experimental side (63  $\times$ ).

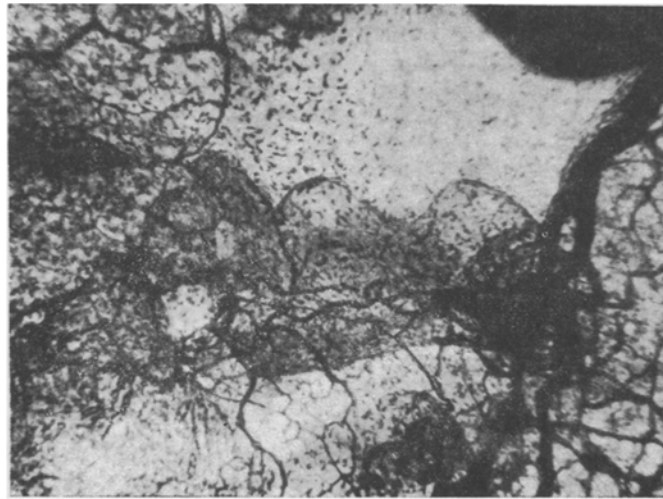


Fig. 3. Lymphatic capillary in wall of synovial sheath of tendon of extensor digitorum communis in a dog. Experimental side (24.5  $\times$ ).

The irregular walls of the venules appeared thickened as a result of juxtamural stasis of leukocytes and deposition of fibrin.

The microcirculation of the synovial membranes of the joints plays a mainly resorptive role, which accounts for the absence of effusion into the joint. The abundance of postcapillaries and venules directly beneath the layer of synovial lining cells provides for evacuation of fluid from the joint cavity and from the synovial sheaths. No obstruction to the mechanical mobility of the joint surfaces arises. Limitation of movement in joints, or interference with the sliding movements of tendons is caused by stasis of blood in the vessels with its inevitable consequence – the accumulation of fluid in the interstitial spaces and, in particular, wherever there is fatty areolar tissue. In such places abundant capillary networks are found, with lymphatic vessels passing through.

Obstruction to the venous outflow is reflected in the state of the lymphatic channels. On the side of the operation the lymphatic capillaries and vessels of the limb showed features of lymphostasis. Along the course of the lymphatic capillaries and postcapillaries protrusions (Fig. 3) were formed with thin walls. The presence of paravasal fluid in the surrounding tissues increased their translucency.

The slow lymph flow under these conditions was able to increase the volume of transported fluid by not more than twice.

These observations showed that the blood flow in the postcapillaries and venules was very variable. However, this was not always accompanied by sharp changes in the geometry of the vascular network of the synovial membranes. The degree of these changes varied for venules and veins of different orders. The intensity of the anatomical changes depended on the degree of edema; the stage of prestasis was accompanied by less marked structural abnormalities of the vascular network: the loops of vessels did not reach their largest size and disproportion between the afferent and efferent components was not particularly severe.

In the later stage after ligation of the femoral vein the evidence of stasis diminished, the edema of the joint subsided, and movements of the limb were restored. These changes indicate the appearance of developed collaterals of the venous system and improvement of the lymphatic drainage. As a result, the picture of the microcirculation in the synovial membranes returned to normal.

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