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STRUCTURAL AND HISTOCHEMICAL CHARACTERISTICS OF EXPERIMENTAL PERIMUSCULARIZATION OF THE FEMORAL VEIN IN DIFFERENT WAYS

N. S. Zuev, P. V. Dunaev, and V. A. Agarkov

UDC 616.147.3-008.64-036.12-092.9-07

KEY WORDS: vein; blood flow; vessel-tissue relations.

Attempts have recently been made to prevent the reflux of blood in the altered valveless deep veins of the lower limbs by creating artificial valves [2, 4, 6, 8], and also by extravasal constriction by the fascia lata [1] or by perivenous cuffs made of tantalum wire, 0.3 mm in diameter, in the form of a coil [3]. Unfortunately, intravascular valve mechanisms create a turbulent blood flow, which leads to thrombus formation, whereas permanent perivenous stenosing devices, while reducing retrograde reflux of blood, lead to disturbance of the centripetal blood flow.

Accordingly, in the investigation described below, an attempt was made to create partially acting perivenous mechanisms, using autogenous tissue for this purpose.

EXPERIMENTAL METHOD

Operations were performed on 32 mongrel dogs under general anesthesia (intrapleural injection of 10% hexobarbital solution in a dose of 0.5 mg/kg body weight). Two methods of perimuscularization were used, followed by comparative study of the histological changes in the structure of the musculo-vasal complex in order to choose the optimal version.

An anterior flap was cut in the frontal plane from the medial head of the quadriceps femoris muscle, located posteriorly to the femoral vein, and after division of its lateral edge it was transposed to the anterior surface of the mobilized femoral vein behind the artery (18 dogs). The edges of the excised piece of muscle were then sutured together and the vein was buried in its mass.

A tunnel was formed in the thickness of the medial head of the quadriceps femoris muscle (14 dogs). After division of the mobilized femoral vein distally to the level of the tunnel, the proximal segment of the divided vein was passed through the tunnel. Continuity of the femoral vein was restored by a vascular suture apparatus, by the end to end technique.

A segment of the perimuscularized vein was chosen during life under general anesthesia for histological investigation of the musculo-vasal complex 2 weeks, 1, 3, and 6 months, and 1 year after the operation. Material was fixed in 10% neutral formalin and in Carnoy's fluid, and then taken up through absolute alcohols. For the same preparation two or three experiments were undertaken by each method and at each time.

Serial paraffin histological sections were stained with hematoxylin and eosin and by Van Gieson's and Weigert's methods. Staining for histochemical study was carried out by the methods of McManus, Hale, Ritter and Oleson, and Brachet. The experimental results were analyzed in total for all experiments at each time of observation, but separately for each preparation.

Department of General Surgery and Department of Histology and Embryology, Tyumen' Medical Institute.
(Presented by Academician of the Academy of Medical Sciences of the USSR Yu. I. Borodin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 99, No. 5, pp. 622-624, May, 1985. Original article submitted February 3, 1984.

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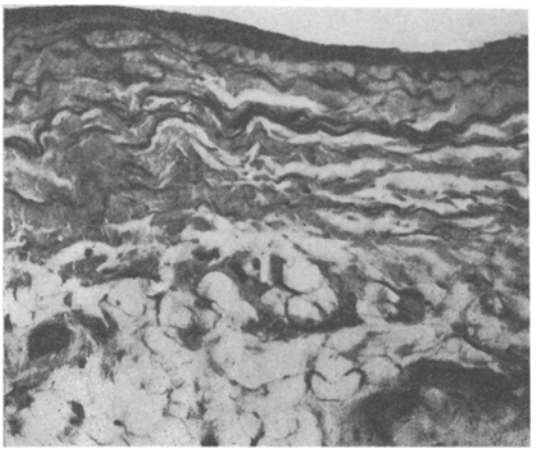

Fig. 1. Musculo-venous complex 12 months after perimuscularization. Atrophy of muscle fibers and increase in mass of endomysium. PAS reaction, 140 ×.

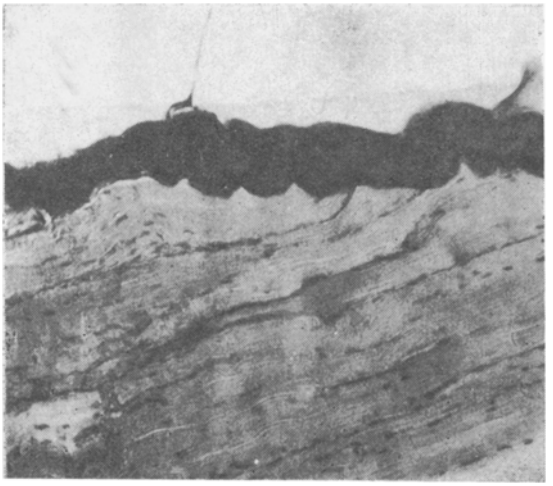

Fig. 2. Musculo-venous complex 12 months after perimuscularization. Main mass of muscle surrounding vein preserves its usual structure and is functionally normal. Van Gieson's stain, 140 ×.

EXPERIMENTAL RESULTS

The experiment showed that 2 weeks and up to 3 months after the operation the transposed muscle flap was separated into fibers. In some preparations edema of the endomysium was observed. The vascular network of the muscle flap was reduced in density. At this time the flaps showed no degenerative or dystrophic changes, and was not replaced by loose fibrous connective tissue. However, the PAS reaction revealed a decrease in the number of glycogen granules and an increase in the concentration of neutral glycoprotein in the sarcoplasm of the fibers, and according to investigations by several workers [5, 7] this is evidence of hypoxic changes in the tissues.

After 6 months, about 50% of the muscle tissue, especially in the region of the suture, showed dystrophic changes. In this zone edema of the connective-tissue stroma was observed. The adventitia in the wall of the vein was rich in fat cells, and a band of fat could be seen between the adventitia and the muscle, evidence of the absence of adhesions between them.

By 12 months the lumen of the vein could be clearly identified. There were no marked changes in the endothelium. The muscular coat was thickened. The adventitia changed without any sharp boundaries into connective tissue of the muscle flap, in which atrophy of the muscle fibers and an increase in the mass of the

endomysium, characterizing replacement of muscle fibers by connective tissue, were conspicuous. Hardly any unchanged muscle fibers were present. The commonest cells were fat cells. The vascular network was ill-defined.

No marked changes could be seen in the wall of the vein 2 weeks and up to 3 months after the operation. In the immediate vicinity of its adventitial layer, a band of loose fibrous connective tissue containing mainly fat cells could be seen. Areas of the muscle flap adjacent to the vein appeared as twisted, tapering muscle fibers. In some areas the muscle fibers were edematous and had lost their cross-striation. In the peripheral zones of the muscle, in the region of perimuscularization, the original structure of the muscle fibers was completely preserved.

By the 6th month of the experiment, toward the periphery from the adventitia of the vein, loose connective tissue with fat cells could be identified. With increasing distance from the vein wall, in the richly vascularized tissue of the muscle flap, thin, twisted muscle fibers, but preserving their cross-striation, and containing glycogen granules, were present. Toward the periphery from the vein the muscle fibers preserved their original structure. In areas adjacent to the vein, in the region of the connective-tissue band, signs of regeneration of muscle fibers in the form of bulbs of growth could be seen.

After 12 months the lumen of the vein was preserved and the endothelium was unchanged. However, some thickening of the subendothelial layer and hypertrophy of the muscular coat of the vein could be identified. The main mass of the muscle flap (Fig. 2) preserved its usual structure and was functionally normal.

Generalization of the results of these morphological, physiological, and histochemical investigations showed that marked histological structural changes take place in the muscle surrounding the vessel, in the form of dystrophy, edema of its fibers, and a decrease in their glycogen and RNA content. These changes were most marked by the 12th month after the operation. Changes of this magnitude are connected with ischemia of the muscle flap, as is confirmed by the results of the histological investigations and the unsuitable conditions for its function.

A different histological structural picture was observed in cases when the muscle underwent structural and dystrophic changes only in the immediate vicinity of the adventitia of the vein, reflecting more favorable conditions for functioning of the muscle and also, perhaps, for regulation of the blood drainage through perimuscarlization of the veins.

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