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EVALUATION OF THE RESULTS OF ARTERIAL RECONSTRUCTIONS ACCOMPANIED BY ARTERIOVENOUS ANASTOMOSIS

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KEY WORDS: arteriovenous anastomosis; electrodiagnostic methods.

Reports have recently been published on a new type of operation intended for use in the treatment of patients with obliterative diseases of the limb arteries. These operations consist of arterial reconstructions accompanied by the formation of an arteriovenous anastomosis (AVA), used as the last opportunity to prevent amputation of the limb in cases when, because of insufficient capacity of the drainage vessels, traditional reconstructive operations on arteries had little prospect of success. Formation of an AVA provided a new drainage channel through the veins, and thus increased the velocity of blood flow in the prosthesis, preventing its thrombosis [1, 3-5]. However, these reports have been few in number and opinions regarding the effectiveness of the suggested method conflict. The main objection is that when an AVA is formed most of the blood flow is "dumped" from the prosthesis into the vein, and for that reason the volume of the blood flow entering the distal arterial bed may be insufficient to supply the limb with blood after the operation [6].

Because of the absence of unanimity on this question it was decided to carry out an experimental study. An electromagnetic flowmeter was used for the hemodynamic measurements, and blood supply and the intensity of ischemia were estimated by means of an electrodiagnostic method, namely a study of the electrical excitability of the limb muscles after the operation.

EXPERIMENTAL METHOD

Experiments were carried out on 25 adult mongrel dogs of both sexes weighing from 14 to 22 kg. The animals were divided into five experimental groups with five dogs in each group. Dogs of group 1 (control) underwent the operation of ileofemoral replacement by a graft of human umbilical vein (diameter 5 mm) and a model of incompetence of the drainage channels was created. This was done by ligating and dividing all collaterals of the femoral artery between its anastomosis with the graft and the site of origin of the ramus saphenus (Fig. 1). The femoral artery also was itself ligated just below the origin of the r. saphenus. The prosthesis developed thrombosis in all the animals of this group during the 1st day after the operation.

In addition to arterial replacement and creation of a model of incompetence of the drainage channels, in the other 20 dogs an AVA was formed between the femoral artery and femoral vein. In all cases the AVA was situated 2-3 cm below the prosthesis, and only the dimensions of the AVA differed: in dogs of group 2 the diameter of the anastomosis was 1-2 mm, i.e., 20-40% of the diameter of the graft; in dogs of groups 3, 4, and 5 its diameter was 2-3 mm (40-60%), 3-4 mm (60-80%), and 4-5 mm (80-100%), respectively.

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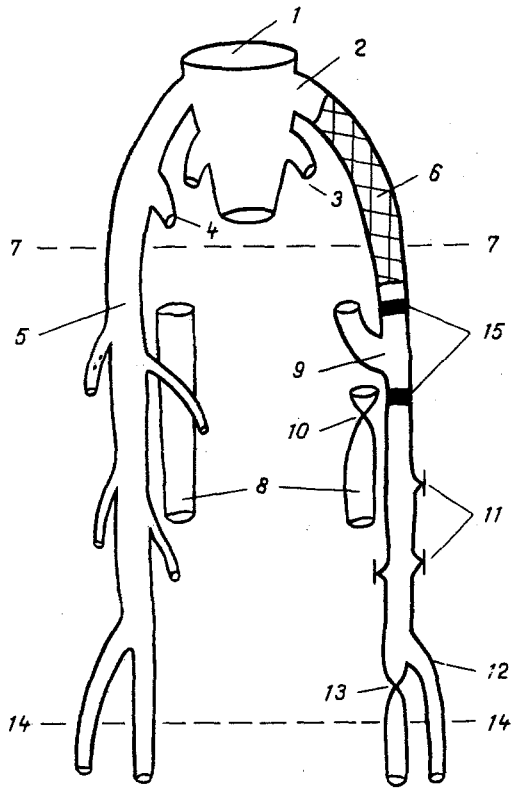

Fig. 1. Scheme of operation: 1) aorta; 2) external iliac artery; 3) internal iliac artery; 4) profunda femoris artery; 5) femoral artery; 6) graft; 7) level of inguinal ligament; 8) femoral vein; 9) AVA; 10) site of ligation of femoral vein; 11) ligated collaterals of femoral artery; 12) ramus saphenus; 13) site of ligation of femoral artery; 14) level of knee joint; 15) levels of application of flowmeter transducers.

EXPERIMENTAL RESULTS

The velocity of the blood flow in the middle third of the femoral artery (physiological normal state) before grafting averaged 78 ml/min, and after grafting and reduction of the capacity of the recipient bed, it was 55 ml/min. Naturally at this stage of the operation the velocity of the blood flow in the graft was the same. After formation of an AVA the velocity of the blood flow in the graft was increased in all cases: in the dogs of group 2 on average to 72.6 ml/min, in dogs of groups 3, 4, and 5 — to 112.6, 208.6, and 380.2 ml/min, respectively. In the animals of group 2 the increase in the velocity of the blood flow in the graft was insufficient to maintain its patency: in four dogs the graft underwent thrombosis during the 1st day after the operation, in one dog the graft remained patent for 23 days after the operation. In the animals of groups 3, 4, and 5 the grafts were patent throughout the period of observation (up to 68 days after the operation).

Besides an increase in the velocity of the blood flow in the graft a further decrease was observed in the volume of the blood flow reaching the peripheral part of the limb: by 2.5% on average in group 2, by 11, 28.9, and 60.7% in groups 3, 4, and 5, respectively. As a result of this, a certain degree of ischemia must have developed and must have been responsible for the worsening of the functional state of the limb. In the only dog of group 2 with a patent graft and in all the dogs of group 3, the general state and functional state of the limb was good: on the day after the operation the animals were able to stand on the affected limb. In dogs of group 4 and, in particular, of group 5, both the general state and the state of the affected limb was worse. The animals were apathetic and inhibited, and during the first 1 or 2 weeks they would not stand on the affected limb, and after that they limped. One week later the process was localized, and at the level of the tarsal joint.

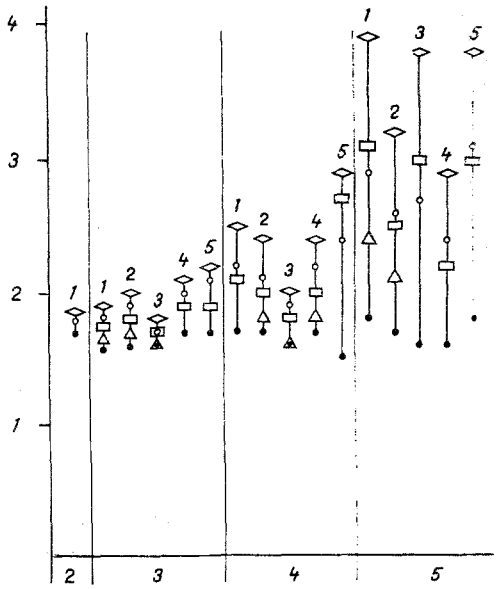

Fig. 2. Threshold voltage. Vertical axis — threshold voltage of stimulating pulses (V); horizontal axis — group of animals. Filled circles — before operation; empty shapes — after operation: circles 3-4 days, rhombi — 7-10 days, rectangles — 1 month, triangles — 2 months. Numbers alongside experimental points are the numbers of the experiments for each group.

As one method of indirect assessment of the blood supply we investigated the electrical excitability of the leg muscles of the affected limb. This method, which is based on the known property of skeletal muscles to change their electrical resistance during contraction [2], can be used to detect a disturbance of the principal function of a muscle, namely its ability to contract actively. In the present case these disturbances were evidence of pathological changes in the state of neuromuscular apparatus, due to insufficiency of the blood supply to the affected limb. Two needle electrodes were inserted into the leg muscle and square electrical pulses 1 msec in duration were applied with a following frequency of 1 Hz, and by gradually increasing the voltage of the pulses, the minimal (threshold) voltage to evoke a muscular response was determined.

Before the operation the threshold voltage varied from 1.5 to 1.8 V. On the 3rd-4th days after the operation the threshold voltage was increased in one dog of group 2 with a patent graft and in the dogs of group 3 up to 1.7-2.1 V, i.e., by 5.9-23.5% compared with the preoperative period. In the dogs of groups 4 and 5 the threshold voltage was 1.9-3.1 V (Fig. 2). The threshold voltage increased even more on the 7th-10th day after the operation and exceeded the preoperative level in the dogs of group 2 by 8.8% (1.85 V), whereas in animals of groups 3, 4, and 5 the threshold voltage was 1.8-2.2, 2.0-2.9, and 2.9-3.9 V, respectively, i.e., it increased on average by 21.9, 48.8, and 107.1%. The highest threshold voltage, more than twice the physiological normal level, was observed in experiments in which leg muscle biopsy specimens showed destructive changes. By the third control period, 30-35 days after the operation, the threshold voltage was lowered in group 3 virtually to the preoperative level, in group 4 it was 1.8-2.7 V (i.e., on average 29.3% above the preoperative level), and in group 5 it was 2.2-3.1 V (62.3% above the preoperative level). In the dog of group 2, no investigation was carried out at this and the next control period, for thrombosis of the graft had occurred 23 days after the operation.

From 60 to 65 days after the operation the threshold voltage in the animals of groups 3 and 4 was virtually normal, whereas in the dogs of group 5 it was 23.5-33% higher than the preoperative level. Values of electrical excitability of the muscles correlated closely with the results of the hemodynamic measurements and direct observations on the state of the animals after the operation, and also with the results of histologic investigations. The level of restoration of the blood flow in the grafted limb could therefore be estimated reliably and the effectiveness of the operation judged.

The best results of arterial reconstructions accompanied by the formation of an AVA were thus observed in the dogs of experimental group 3, in which the diameter of the AVA was 40-60% of the diameter of the graft, for the prostheses were patent throughout the period of postoperative observation and the volume of the blood flow reaching the distal arterial bed was an adequate blood supply for the limb. Consequently, for the prevention of early postoperative thrombosis when arterial reconstructions are performed and the state of the drainage channels is poor, it is advisable to perform an AVA in addition. In such cases the AVA with a diameter equal to 40-60% of the diameter of the graft is optimal.

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SEROTONIN TURNOVER IN PLATELETS AND MICROVASCULAR HEMOSTASIS IN SPONTANEOUS HYPERTENSION

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KEY WORDS: spontaneous arterial hypertension; platelets; laser beam; serotonin; hemostasis.

Elevation of the thrombogenic potential of blood vessels in hypertension is accompanied by changes in platelet function and by definite modification to the platelet–vessel wall system [1, 4]. Mechanism of interaction between platelets and the vessel wall during the formation of a platelet thrombus are connected with release of thromboxane A_2, serotonin (5-HT), and other substances from the dense granules and α-granules of the platelets [5]. According to data in the literature [10], 5-HT turnover characterizes the level of platelet function to a greater degree than metabolism of other release factors. Changes in the thromboresistance of the vessels can be studied in vivo by quantitative estimation of thrombus formation following strictly graded injury to blood vessels [4]. The aim of this investigation was to study 5-HT turnover in the platelets and the dynamics of thrombus formation in arterioles and venules of the small intestinal mesentery of spontaneously hypertensive rats (SHR).

EXPERIMENTAL METHOD

Experiments were carried out on 69 male albino rats weighing 380-400 g, of which 40 rats constituted a control group. Changes in 5-HT turnover in the platelets and the dynamics of thrombus formation in arterioles and venules of the mesentery were studied during a long period of raised blood pressure (BP) in 29 SHR. BP was measured by an acute method in the carotid artery, and in the hypertensive rats it was 180 ± 10 mm Hg. 5-HT turnover in the platelets was investigated by determination of its initial level, its rate of uptake through assimilation, and by the study of its transport and accumulation in the platelets and its release. The 5-HT concentration in platelets was determined by the method in [3]. To study

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