ЭКСПЕРИМЕНТАЛЬНОЕ ИЗУЧЕНИЕ АНАТОМО-ГИСТОЛОГИЧЕСКОГО СТРОЕНИЯ ЭКСТРАКАРДИАЛЬНЫХ СОСУДОВ У КРОЛИКОВ

Мустофоев Зафаржон Мустафо угли, к.м.н.доцент.
кафедры анатомии человека
Самаркандского государственного медицинского университета,
Самарканд, Узбекистан

Резюме: В данной статье было изучено коллатеральное кровообращение сердца при его патологических состояниях в эксперименте на кроликах. А также кровеносные сосуды сердца в условиях экспериментального стеноза брюшной аорты на девяти кроликах. Операция стенозирования брюшной аорты производилась под эфирным наркозом.

Ключевые слова: кролик, кровообращение, экспериментальная стеноза, кровеносный сосуд, аорта, сердце, стенозирование.

EXPERIMENTAL STUDY OF THE ANATOMICO-HISTOLOGICAL STRUCTURE OF EXTRACARDIAC VESSELS IN RABBITS

Mustafoev Zafarjon Mustafa Oglu
PhD, Associate Professor,
Department of Human Anatomy,
Samarkand State Medical University,
Samarkand, Uzbekistan

Abstract: In this article, the collateral circulation of the heart was studied in its pathological conditions in an experiment on rabbits. And also the blood vessels of the heart under conditions of experimental stenosis of the abdominal aorta on nine rabbits. The operation of stenosis of the abdominal aorta was performed under ether anesthesia.

Key words: rabbit, blood circulation, experimental stenosis, blood vessel, aorta, heart, stenosis.

Introduction. Extensive anatomical literature exists on the coronary circulation of the heart in humans and animals, both under normal conditions and in experiments [1,4]. However, many questions regarding cardiac blood supply remain insufficiently studied. In particular, few studies have examined cardiac vessels during collateral circulation after vessel occlusion in cardiac pathology [3,5]. Only recently have publications emerged on collateral circulation in heart pathology [2,6].

Objective. To study collateral circulation of the heart under pathological conditions in an experimental rabbit model.

Materials and Methods. Thoracic aortic stenosis surgery in rabbits was performed under ether anesthesia combined with local infiltration anesthesia using 0.5% novocaine solution. After a skin incision on the ventral trunk wall, the sternum was exposed and split longitudinally into two halves. The aorta was dissected free, and a thick silk thread was passed underneath it using a Deschamps needle. The ends of the thread were tied over the aorta, with the knot gradually tightened to achieve the desired degree of aortic narrowing. Following constriction, the wound was closed in layers.

Postmortem, the blood vessels were injected with an aqueous suspension of India ink diluted 1:4. After injection, the heart was fixed in 20% formalin solution. On the second day after fixation, the dimensions and weight of the heart were determined. Cleared specimens were examined under MBS-2 and MBI-6 microscopes. For comparison, the hearts and their intramural blood vessels, as well as electrocardiographic recordings, were studied in 8 healthy rabbits.

Results. The rabbit heart is supplied primarily by two coronary arteries originating from the aorta at the level of the free edge of the semilunar valves. The vascular network is most prominent in the subepicardial layer, where vessels branch into small twigs resembling fir tree branches. In the muscular layer, vessels are smaller, oriented along muscle fibers, though some run in various directions. In a rabbit euthanized 2

days after thoracic aortic stenosis, the heart was enlarged. Left ventricular wall thickness increased by 0.8 mm compared to normal, right ventricular wall by 0.2 mm, resulting in overall changes in heart dimensions: length exceeded normal by 0.6 cm, width by 0.22 cm, thickness by 0.28 cm, and heart weight by 2.74 g. Corresponding vascular changes included increased vessel diameter and straighter course. In the subepicardial layer, vessel diameters ranged from 30–500 microns. Capillary density decreased by 300–500 per mm². In the muscular layer, changes were milder, with diameter increases of no more than 5–10 microns compared to normal.

At 20 days post-aortic stenosis, cardiac vessels showed significant diameter enlargement: up to 800 μm in the subepicardial layer and 120 μm in the muscular layer. Vessels adopted a narrow branching pattern, with reduced capillary density.

These experiments demonstrate that experimental thoracic aortic stenosis in rabbits induces functional hypertrophy of the ventricular walls, predominantly the left ventricle. In another series, cardiac blood vessels were studied in nine rabbits following experimental abdominal aortic stenosis.

On the first postoperative day, animals refused food, exhibited reduced activity, weak femoral artery pulse, and heart rate of 60–80 bpm (normal: 100–120 bpm). On the second day, hindlimb paresis developed. Four rabbits died within the first three days; autopsy revealed ascites and hydrothorax. Survivors appeared well, but femoral pulse remained weak and heart rate did not exceed 90 bpm. Thus, heart weight and cardiac index (CI) are inversely related. Experiments were conducted on rabbits of similar body weight (12–18 kg), where normal CI was 0.6–0.8%. In experimental animals, CI ranged from 0.9–1.2% depending on survival time post-stenosis. The difference between longitudinal and transverse heart dimensions was 3–5 cm normally and 2–4 cm experimentally. Heart mass and size increased mainly due to left ventricular wall thickening, with minor right ventricular contribution and no change in atrial wall thickness. Vascular responses in cardiac stenosis of the abdominal aorta mirrored those in thoracic aortic stenosis, corresponding to myocardial changes. Normally, the rabbit heart is supplied by two coronary arteries that branch in the subepicardial layer

into II, III, and IV order arteries (diameters 60–800 μm), forming a dense anastomotic network. Other vessels penetrate the muscular layer, dichotomously branching into tree-like patterns with delicate anastomoses. Vessels of VI order (20–40 μm) reach the subendocardial layer. Capillary density in the muscular layer is 7800–8900 per cm². At 2 days post-abdominal aortic stenosis, vessel injection improved, with normal sequential branching and increased diameters; capillary density remained at the upper normal limit. By day 20, large-diameter vessel walls thickened, small-network anastomoses dilated, and capillary density per cm² increased.

Conclusion. Thus, heart weight and cardiac index (CI) are inversely proportional. In rabbits, CI depends on survival time post-aortic stenosis and ranged from 0.9–1.2%. The data obtained in these series serve as initial, control values for further investigation of collateral cardiac circulation against the background of the described pathological conditions.

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