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by A. M. Domotskiy

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ARTERIAL SUTURE IN ACUTE RADIATION SICKNESS

Following is a translation of an article by Assistant Professor A. M. Demetskiy, of the Department of Operative Surgery and Topographic Anatomy (director: Docent V. Kh. Mitroshenko), of the Vitebsk Medical Institute, in Zdravookhraneniye Belorussii (Public Health of Belorussia) Vol. V., No. 1, Minsk, January, 1950, pages 23-25/

In the literature available to us, the problem of the use of manual suture of the arteries in acute radiation sickness is discussed in several works (K. K. Gol'dgammer and B. L. Razgorvorov, 1956; P. I. Atavin, 1957). However, the outcome of this type of suture was inadequately discussed.

The purpose of the present experimental research is the ascertainment of the results of manual circular arterial suture and lateral arterial suture used at various periods of acute radiation sickness of average degree of severity.

The experiments were carried out on clinically healthy, adult dogs (mongrels) weighing from 10 to 25 kilograms.

In order to obtain experimental radiation sickness, the dogs were subjected to x-ray radiation. The general one-time radiation was effected from the top of the dog by means of a therapeutic x-ray machine of the RUM-3 type having the following technical specifications: voltage, 215 kilovolts, current 15 milliamperes, focal length 120 centimeters, filters: copper 0.5 mm and aluminum one millimeter, exposure time 65-75 minutes, dosage 350-400 roentgens.

Four periods were noted in the development of acute radiation sickness: initial, latent, climax, and convalescent.

In the initial period, during the first hours after radiation the animals were excited, their body temperature rose to 39°, and they had hyperemia of the mucous membranes of the eyes and lacrimation. Blood: neutrophilic leukocytosis (as many as 15,000-16,000 l.), acceleration of coagulability of the blood, and increase in the number of thrombocytes (in some of the dogs, 110-115 thrombocytes per thousand erythrocytes). Three to four hours later the animals calmed down and even became passive. Then a left shift of the leukocyte formula occurred (the number of bacillonucleonic, young, and myelocyte cells went as high as 23%, and relative lymphopenia was determined). One to two days later, all these changes disappeared and subsequently the disease proceeded latently.

The latent period lasted for 7-14 days. During this period the animals seemed to be healthy, but a gradual development of leukopenia was noted in them. By the end of the latent period the number of leukocytes fell to 5,000.

On the eight to fifteenth day after the radiation, the dogs' conditions suddenly became worse. This was the beginning of the climax period of the disease. The animals became limp and adynamic. They displayed clearly expressed catarrhal symptoms of the eyes (suppurative conjunctivitis in some animals), nose, and upper respiratory tracts, sialorrhoea, complete loss of appetite (although they drank water), diarrhea, increase of body temperature to 40-41°C, and weight loss of 2-3 kilograms. This period was characterized by clearly expressed hematological shifts. The number of leukocytes dropped to 2,000-2,500. Smears revealed pathologically changed leukocytes: hypersegmented neutrophils, their toxic granulation, vacuolization of the protoplasm and nuclei, and sometimes karyorrhexis. The number of lymphocytes constituted about 5%. A critical drop in the number of thrombocytes occurred. On the twentieth to twenty-second day there were 4-6 thrombocytes per thousand erythrocytes. The blood coagulability time increased 3-4 times. Anemia developed more slowly than leukopenia. The lowest figures for the percentage of hemoglobin and the number of erythrocytes was on the twentieth to twenty-fifth day, when the number of erythrocytes dropped from 5-6 to 3.5-4 million, and the percentage of hemoglobin dropped to 40-35 according to Sala.

If, by the twentieth to twenty-fifth day after radiation, the condition of the animals did not improve, they died. When the radiation dosage was 400 roentgens the dogs died on the eighteenth to twenty-first day, and when it was 350 roentgens they died on the twenty-second to twenty-fifth.

Postmortems on the dogs revealed: polyemia of the organs, numerous hemorrhages in the lungs, pleura, pericardium, under the capsule of the kidneys, and in the mucous membranes of the stomach, intestine, and urinary bladder.

In the animals that recovered, the described clinical and hematological changes decreased noticeably by the twenty-fifth to thirtieth day. The outward symptoms disappeared by that time. However, the normalization of the peripheral blood began somewhat later. By the thirty-fifth to fortieth day the number of leukocytes rose to 4000-5000, and thrombocytes to 10-20 per thousand erythrocytes. The restoration of the red blood occurred more slowly. By the time indicated the blood coagulability was slower than before the exposure to radiation.

Fifteen dogs were operated on during each of the described periods of radiation sickness.

Under aseptic conditions and morphine and novocaine anesthesia, the arteria carotis and the arteria femoralis were laid bare for a distance of 5-6 centimeters. Before they were laid bare, 10 milliliters of a 2-percent solution of novocaine was introduced into the

vascular bed. A sector of the arteria corotis one centimeter long was excised, and the arteria femoralis was dissected for 1.5 centimeters along the axis. The former instance there was anastomosis of the sectors of the arteria according to our modification of the invagination method of uniting the vessels (Zdravookhraneniye Belorussii, 1959, No. 5), and in the latter, the longitudinal wound was closed with a lateral, winding, continuous silk suture. After the vascular bed was restored, the wound was sewn tightly in layers.

Ten days after the operation intravital angiography was carried out with a 40-percent sergosin solution, and, before the animal was killed, with a solution of barium sulfate.

After the pathologoanatomical autopsy of the dogs that died and that were killed, the vascular sector that had been operated on was excised, was dissected along the axis, photographed, fixed in a 10-percent solution of formalin, and the area of the vascular suture was subjected to histological investigation.

The outcome of the vascular sutures made at various periods of acute radiation sickness is shown in the table.

Periods of acute radiation disease	Outcome of circular suture							Outcome of lateral continuous suture						
	Number of Experiments	Normal permeability	Stenosis	Thrombi		Separation of suture	Suppuration	Number of experiments	Normal permeability	Stenosis	Thrombi		Separation of suture	Suppuration
				Wall	Total						Wall	Total		
Initial	15	8	2	2	3	-	-	15	10	2	3	-	-	-
Latent	15	5	2	4	4	-	4	15	8	3	3	1	-	-
Climax of Disease	15	12	2	2	7	2	6	15	3	3	5	3	1	1
Recuperation	15	10	2	1	2	-	-	15	12	3	-	-	-	-
Control of group of experiments (without radiation sickness)	15	12	-	2	1	-	-	15	13	2	-	-	-	-

As can be seen from the table, the best results were obtained when the vascular suture was used during the period of recuperation and in the initial period.

Complication (hemorrhage, formation of thrombi, suppuration, and Separation of the suture) occurred more frequently in instances of operational interference during the latent period and during the disease's climax period. During these periods of the disease there was increased vulnerability of the outer and inner membranes of the arteries, and in the development of hemorrhages around the vessels; under the adventitia and in the intima, in places where the vascular clamps were applied, there were variously-expressed hemorrhages. For example, hematomas formed under the adventitia, detaching it from the tunica media, and black transverse stripes developed on the intima. In one third of the cases these places revealed aneurysm-like expansions of the artery that exceeded its diameter by 1 1/2 -2 times. This condition was not observed even once when the suture was applied to the vessel during the recuperative period or when the unirradiated dogs were operated on. By the thirtieth day after the operation, the artery was surrounded, in the area of the suture, by abundantly developed cicatrical tissue and was tightly adhered to the surrounding tissue.

When there was complete permeability of the vessel or when a wall thrombus formed, the inner surface of the arteries on the twenty-fifth to thirtieth day after the application of the suture (independent of the period of the disease) was smooth and shiny. This was a sign that the suture was healing properly. Along the suture line the defect in the vascular wall was filled with a whitish stripe. When the arterial suture was applied during the initial period or during the recuperative period, this stripe was almost unnoticeable. When the suture was applied during the latent period or during the period of climax, it was considerably wider and could be seen easily by the naked eye, forming as it were, a groove-like tissue defect.

Microscopic investigation showed that from the fifteenth to the eighteenth day after the operation, the defect of the vascular wall along the suture line is gradually restored by young connective tissue growing from the adventitia. On the twenty-fifth to thirtieth day after the operation, or later, the vascular cicatrix represents solid cicatrical tissue, and, on the side of the vascular lumen, is covered with endothelium. Silk threads were detected in the outer layer of the artery and were surrounded by gigantic cells of foreign bodies (symplasts). Around each silk thread there was leukocyte infiltration, which was most clearly expressed during the recuperative period. On the fortieth day after the operation, a sparse network of fine elastic fibers appeared in the area of the vascular cicatrix.

CONCLUSIONS

1. In cases of average severity of acute radiation disease it is possible, under experimental conditions, to apply a manual-circular arterial suture and lateral arterial suture.

2. The outcome of the vascular suture depended upon the period of acute radiation sickness during which the operation was carried out. The best results were obtained when the suture was applied during the initial period or during the recuperative period. The use of the circular vascular suture and the lateral vascular suture during the period of the disease's climax was accompanied by various complications (formation of thrombi, suppuration, and separation of the suture) in more than half the cases.

3. With manual circular suture of the artery, the formation of the cicatrix ended by the thirtieth to fortieth day after its application.

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