

## EXPERIMENTAL CRYOGENIC EFFECTS ON THE CORONARY ARTERIES

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Cryogenic methods are increasingly being used in the surgical treatment of cardiac arrhythmias [1-4, 6, 7]. However, there is no general agreement in the literature on the possibility of using cryogenic methods on the coronary arteries. According to some workers [5], cryogenic therapy ought not to be used on the myocardium, whereas according to others, it presents no risk in the coronary arterial zone [8].

### EXPERIMENTAL METHODS

Experiments were carried out on mongrel dogs weighing 6-19 kg anesthetized with thiopental sodium intravenously. The lungs were ventilated by the R0-5 apparatus. Thoractomy was performed in the fourth intercostal space on the left side. The pericardium was opened and the KAU-01 cryosurgical instrument, connected to a reservoir with nitrous oxide was applied to the interventricular branch of the left coronary artery at the level of its middle third. The diameter of the cryoapplicator tip was 5 mm, the exposure lasted 120 sec, and

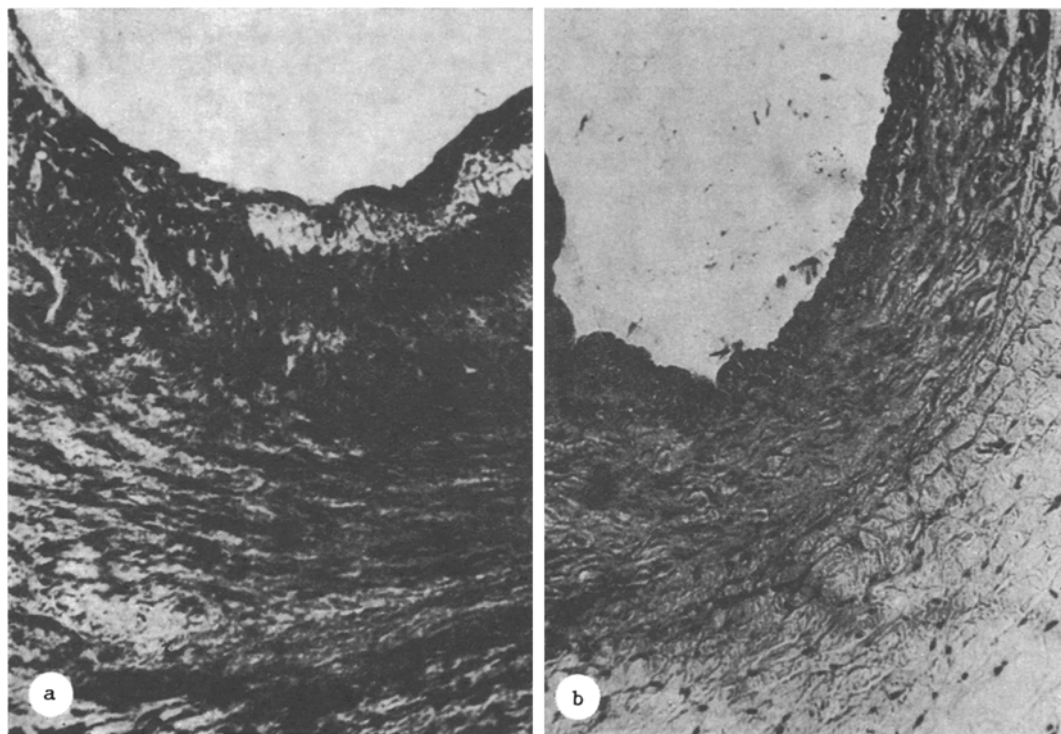


Fig. 1. Artery after cryogenic treatment. a) Three months after treatment: hyperplasia of intima (80×); b) eight months after treatment; mild hyperplasia of intima (160×) Hematoxylin and eosin.

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the temperature was reduced to  $-120^{\circ}\text{C}$ . In some cases, cryogenic treatment was also applied to the diagonal branch. In all cases the diameter of the arteries did not exceed 1.5 mm. The pericardial wound and the incision in the chest wall were then sutured and air was withdrawn from the pleural cavity. Acute experiments were performed on four dogs and chronic on 18 dogs. Material was removed after 11 and 21 days, and also after 1, 3, 4, 5, 6, and 8 months. At the site of cryoapplication the myocardium was excised together with the artery. The preparations were fixed in 10% formalin solution or in Bouin's solution and embedded in paraffin wax. Histological sections were stained with hematoxylin and eosin. The diameter of the vessel and thickness of the intima were determined with an ocular micrometer.

#### EXPERIMENTAL RESULTS

Between 30 and 40 sec after application of the cryogenic instrument to the coronary artery acute ischemia was recorded on the ECG, and disappeared on average 3 min after the end of cryoapplication. The ischemic zones were clearly demarcated: they were bluish in color and their contractility was reduced. Macroscopically, hyperemia and hemorrhages were observed in the zone of cryogenic therapy. Microscopically, the lumen of the vessels subjected to cryogenic action remained intact for 24 h without the development of thrombosis.

In the chronic experiment (as also in the acute), cryogenic therapy was not complicated by acute myocardial infarction in any of the animals. The arteries were not thrombosed 11 days after cryogenic therapy and the intima consisted of a single layer of endothelial cells. Two of six arteries 21 days after cryogenic therapy were thrombosed, and a juxtamural thrombus covered with neointima was observed in one of them. In one case focal hyperplasia of the intima was observed. Only in one artery was the intima unchanged. In seven of 10 arteries hyperplasia of the intima was found 1 month after the operation. In two cases thrombosis of the arteries was present. In one case, however, the artery was not thrombosed and its intima was unchanged. In five of 10 arteries hyperplasia of the intima was observed 3 months after cryogenic therapy (Fig. 1a). One artery was thrombosed, and in four arteries hyperplasia of the intima was not observed. In five of seven cases hyperplasia of the intima was found 4, 5, 6, and 8 months after cryogenic therapy (Fig. 1b). In two cases the intima of the arteries was unchanged.

After cryogenic action on the coronary arteries, under 1.5 mm in diameter, in most cases hyperplasia of the intima thus arises. Cryogenic action may also be complicated by thrombosis of the coronary arteries.

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