

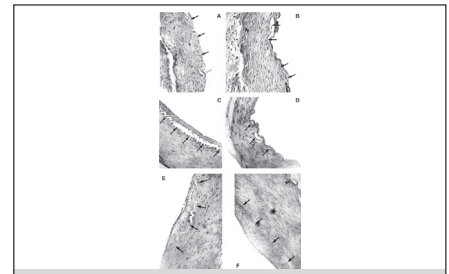
# Micromorphology of Skeletonized and Pedicled Internal Thoracic and Radial Arteries

Sergey Mamchur, MD, PhD,<sup>\*</sup> Nikita Bokhan, MD,<sup>\*</sup> Yuri Vecherskij, MD, PhD,<sup>†</sup> and Egor Malysenko, MD, PhD<sup>‡</sup>

The objective of the study was to estimate the internal thoracic arteries (ITA) and radial arteries (RA) micromorphologic features by light microscopy after harvesting them using the skeletonization and pedicled methods in patients undergoing coronary artery bypass grafting. The micromorphologic characteristics of ITA and RA were studied by luminous microscopy in 61 patients undergoing coronary artery bypass grafting. A total of 122 ITA and RA segments harvested during surgery, fixed in formalin, and stained with hematoxyline and eosin were evaluated. The mean intima-media thickness of ITA was 9.2 and 134.7  $\mu\text{m}$  and that of RA was 9.1 and 334.2  $\mu\text{m}$ , respectively. In the distal segment of ITA the media-intima relation was 1.5 times bigger than in the proximal segment. None of ITA specimens contained atherosclerotic plaques or lipid inclusions. Atherosclerotic plaques were found in 3 (5%) RA specimens. Other degenerative changes were detected in 30%-74.2% of the specimens: splitting of internal elastic lamina, reduced tortuosity of the internal elastic lamina, and thickening and detachment of the intima; their incidence was associated with the skeletonization of the vessels. In conclusion, the incidence of ITA and RA degenerative changes varies from 30%-74.2% and its increase is associated with the skeletonization of the vessels, which is statistically significant. The media of the RA is 2.5 times thicker than that of the ITA ( $P < 0.01$ ). This fact shows that RA has higher spasmogenic potential than that of ITA. The distal segment of the ITA has 1.5 times bigger media-intima relation than the proximal segment. Therefore, in case of enough graft length, it is recommended to avoid the distal segment and cut it off.

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Degenerative changes in human ITA and RA. Hematoxylin-eosin staining, magnification 160 $\times$ .

## Central Message

The harvesting method of ITA and RA influences their micromorphologic features.

## Perspective

The incidence of ITA and RA degenerative changes varies from 30%-74.2% and its increase is statistically significantly associated with the skeletonization of the vessels. The distal segment of the ITA has 1.5 times bigger media-intima relation than the proximal segment. Therefore, in case of enough graft length, it is recommended to avoid the distal segment and cut it off.

See Editorial Commentary pages 121–122.

## INTRODUCTION

The widespread application of autoarterial grafts in coronary surgery significantly improves the long-term results of coronary

<sup>\*</sup>Department of diagnosis of cardiovascular diseases, Research Institute for Complex Issues of Cardiovascular Diseases, Kemerovo, Russian Federation

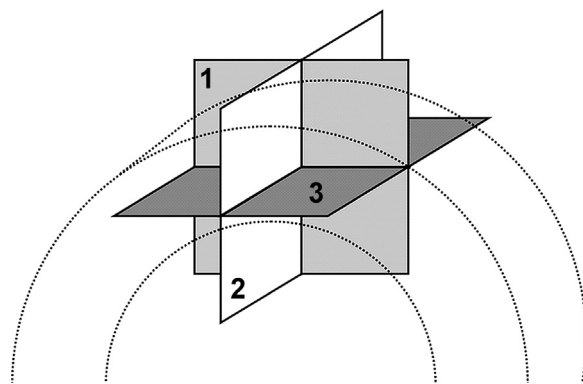
<sup>†</sup>Department of Cardiovascular Surgery, Research Institute of Cardiology, Tomsk, Russian Federation

<sup>‡</sup>Department of Cardiovascular Surgery, Research Institute for Complex Issues of Cardiovascular Diseases, Kemerovo, Russian Federation

Address reprint requests to Sergey Mamchur, MD, PhD, Department of diagnosis of cardiovascular diseases, Research Institute for Complex Issues of Cardiovascular Diseases, 6 Sosnovy Blvd, Kemerovo 650002, Russian Federation. E-mail: [sergei\\_mamchur@mail.ru](mailto:sergei_mamchur@mail.ru)

artery bypass grafting (CABG), due to superior patency of autoarterial grafts compared with autovenous ones.<sup>1–3</sup> However, a serious problem of early graft failure has arisen due to early spasm-causing graft occlusion and intimal hyperplasia.<sup>4–6</sup>

The incidence of autoarterial graft spasms during and after CABG is associated with increased morbidity and mortality mostly after ischemic episodes including myocardial infarction.<sup>7</sup> The mechanisms of autoarterial graft spasms and intimal hyperplasia are not fully understood. There are several possible causes for this, namely artery denervation and inflammatory reaction with the release of spasmogenic and proliferative mediators. One of the main mechanisms predisposing to internal thoracic artery (ITA) and radial artery (RA) spasms is considered to be their mechanical injury during harvesting.



**Figure 1.** The scheme of orientation of 3 mutually perpendicular slices: 1—transversal slice, 2—longitudinal slice, and 3—intramural slice of the media.

Thus, the ITA skeletonization allows increasing the grafts length and decreasing the sternum ischemia, but may result in invisible macroscopic damage to the artery wall.<sup>8</sup>

The heterogeneity of ITA constrictive potential depending on its segment should be taken into consideration. These data were confirmed by Yildiz et al,<sup>9</sup> who studied the effect of the 5-HT<sub>1</sub>-agonist sumatriptan on ITA contractile properties and concluded that its distal segment was more affected by spasmogenic substances. Apparently, the main reason for this is the vascular wall morphology, as the use of autovenous coronary bypass grafts does not cause such complications. In particular, some authors attach great importance to the morphologic features of the grafts owing to the occurrence of their occlusion, especially to intimal hyperplasia,<sup>10,11</sup> even in the early postoperative period.<sup>12</sup> Currently, there are no studies on ITA and RA morphologic changes that are provoked by harvesting methods.

The objective of the study was to estimate the ITA and RA micromorphologic features by luminous microscopy after their harvesting using the skeletonization and pedicled methods in patients undergoing CABG.

## MATERIAL AND METHODS

The study design was approved by the Local Ethical Committee. All patients provided written informed consent. ITA (62 segments) and RA (60 segments) were obtained intraoperatively from 61 consecutive patients aged 63.2 years (quartile range [QR]: 58.3-68.4) undergoing CABG. The inclusion criteria were 3 vessel diseases; both ITAs and 1 RA were harvested. The exclusion criteria were predisposing factors for ITA and RA morphologic changes (a positive history of chest and forearm trauma, arteritis, a history of thoracic radiation therapy, documented aneurisms, and atherosclerosis or endovascular procedures on subclavian artery and its

branches). The mean New York Heart Association (NYHA) class was 2.4 (QR: 2.2-3.2) and the mean angina Canadian Cardiovascular Society (CCS) class was 2.8 (QR: 2.2-3.4). Off-pump CABG was performed in 3 cases (4.9%).

From each patient 2 arterial samples were taken in a randomized manner for each of the samples (RA or ITA). A total of 122 samples were taken, 62 of which were fragments of ITA and 60 were fragments of RAs. All of the grafts were randomized into 2 groups: Group I (32 ITAs and 31 RAs)—skeletonized grafts and Group II (30 ITAs and 29 RAs)—pedicled grafts. In nonselected patients, the second ITA was used as a free graft or as a component of Y-shape graft (overall 21 ITAs in patients). In this case, the proximal segments of ITA were used for histology analysis. The proximal segments of RA harvested intraoperatively were assessed.

All specimens were immersed in nitroglycerin before fixation to minimize spasm and, therefore, obtain objective tunic thickness data. Then, the samples were immediately fixed in 4% neutral formaldehyde solution and embedded in paraffin. We obtained at least 6 slices in mutually perpendicular axes of the vessels (2 in each axis) or more if the length of the specimen was sufficient (Fig. 1). After sectioning and degreasing, the samples were stained with hematoxylin-eosin, and they were studied using a light microscope at magnification from 30× to 160×.

The following morphometric parameters were studied: the diameter of the lumen, the maximal thickness of the intima-media, the intima-media ratio, and the mean angle of myocytes orientation with respect to the vessel long axis (Fig. 2). Then, the presence and prevalence of degenerative and other changes of arteries were visually assessed. An expert pathologist blinded to clinical data examined hematoxylin-eosin-stained sections of paraffin-embedded samples.

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