Histomorphologic superiority of internal thoracic arteries over right gastroepiploic arteries for coronary bypass

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ABSTRACT

Objective: In this study, we compared the histologic and morphometric properties of both internal thoracic arteries and the right gastroepiploic artery (GEA) in patients undergoing coronary artery bypass grafting (CABG).

Methods: We microscopically examined transverse sections of segments of both internal thoracic arteries and the right GEA obtained from 83 consecutive patients who underwent CABG.

Results: There were no significant differences between the internal thoracic arteries. Significant differences were found between the left and right internal thoracic arteries and GEA in the intimal width (21.8, 21.5, and 71.7 μm, respectively; $P < .01$), intima-to-media ratio (0.286, 0.256, and 0.749, respectively; $P < .01$), and media width (148.5, 157.5, and 164.8 μm, respectively; $P = .43$). No atherosclerotic lesions, medial calcification, or intimal thickening were seen in the internal thoracic arteries; however, atherosclerotic lesions were seen in the GEA. The intima of the GEA was thicker than that of the internal thoracic arteries. Intimal thickening of the GEA, but not the internal thoracic arteries, was positively correlated with risk of arteriosclerosis. In patients with diabetes mellitus, dietary/drug therapy and insulin therapy were associated with GEA intimal thickness ($P = .02$ and .01, respectively).

Conclusions: The internal thoracic arteries have equivalent histologic and morphometric properties that differ from those of the GEA only in intimal width. The former had no intimal thickening, and is thus preferable to the GEA for CABG. (J Thorac Cardiovasc Surg 2016;151:1704-8)

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Central Message

The intimal thickness of BITAs is not correlated with risk of arteriosclerosis; BITAs are thus preferable to the GEA for CABG.

Perspective

The present study indicates that the intimas of both internal thoracic arteries do not increase in thickness even in the presence of some risk factors for arteriosclerosis. However, the gastroepiploic artery intima readily thickens because it is easily affected by arteriosclerosis.

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ACQ

Several strategies using arterial conduits have been employed to improve the long-term outcome after coronary artery bypass grafting (CABG).[1] After Higami and colleagues[2] described procurement of the internal thoracic artery (ITA) using a Harmonic scalpel, it became possible to obtain sufficient vessel length for anastomosis to most coronary arteries for bypass grafting. Use of both ITAs (BITAs) for bypass grafts is currently favored. Thus, identification of a third vessel suitable for CABG is needed.[3] The great saphenous vein, right gastroepiploic artery (GEA), and radial artery have been considered as possibilities for the third vessel.[4] Of these, the right GEA has been widely used and investigated as a suitable alternative arterial conduit.[5] However, its small caliber and susceptibility to vasospasm are major drawbacks to its use. The skeletonization technique was initially used to procure the ITA. This technique reportedly increases its caliber, conduit length, and flow capacity.[6,7] Gagliardotto and colleagues[8] introduced the technique of skeletonized GEA procurement in 1998. Skeletonized GEAs can be expected to yield the same benefits as skeletonized ITAs and subsequently

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Abbreviations and Acronyms
BITAs = both internal thoracic arteries
CABG = coronary artery bypass grafting
GEA = gastroepiploic artery
HbA1c = glycated hemoglobin
ITA = internal thoracic artery
LITA = left internal thoracic artery
RITA = right internal thoracic artery

provide a better patency rate than pedicled GEAs. However, few studies have quantitatively evaluated skeletonized GEAs.[9] The aim of our study was to examine the histologic and morphometric properties of BITAs and the GEA in the same patients undergoing CABG.

METHODS

During the 9 years from January 2006 to August 2014, CABG was performed in our hospital in 316 consecutive patients, in 128 of whom skeletonized GEAs and BITAs were used. The stumps of resected GEAs and BITAs of 83 of the patients who underwent coronary bypass surgery were assessed in this study. The segments obtained from the remaining 45 patients were excluded because they were distorted by surgical or pathologic preparation and consequently unsuitable for the morphometric analysis. In all, 79 segments from the left ITA (LITA), 73 from the right ITA (RITA), and 72 from the GEA were examined. The patients' baseline characteristics are summarized in Table 1. The glomerular filtration rate (calculated as mL/min/1.73 m^2) was calculated from the Modification of Diet in Renal Disease equation.[10]

Our indication for the use of the GEA was >75% stenosis of the right coronary territory. The GEAs were dissected distal to the midpoint of the greater curvature of the stomach and proximal to the pylorus. Full skeletonization of the whole length of BITAs and the GEA was performed with an ultrasonic scalpel. After systemic heparinization, the distal ends of the grafts were divided and 0.02% milrinone instilled into them, after which they were wrapped with 0.2% papaverine-soaked gauze. The required lengths of BITAs and the GEA were adjusted according to the target vessels and the redundant distal portions trimmed and sent to the laboratory. An off-pump technique was used in all patients. In our series, no GEAs were discarded on the basis of gross examination after opening the peritoneal cavity or having procured the graft.

Before the study, the patients gave written informed consent to the use of their medical records for research purposes. The institutional review board at our institution approved the study.

Histopathologic Analysis

Tissues obtained from BITAs and the GEA were fixed in 5.25% formaldehyde, then embedded in paraffin wax, after which transverse sections (short-axis segments of the blood vessel) were cut. After dewaxing, the sections were stained with hematoxylin and eosin and Verhoeff-van Gieson. For morphometric analysis, the following variables were measured using a medical imaging system (Osirix MD; Pixmeo, Geneva, Switzerland): maximum intimal width, media width at maximal intimal thickness, and wall thickness. Intimal thickening was also evaluated using the ratio of the maximal intimal width to the media width at maximal intimal thickness. Intimal hyperplasia was defined as >30 μm.[11,12] The maximum intimal width, media width at maximal intimal thickness, and wall thickness were assessed by dividing the section into 8 equal sectors of 45°. Atherosclerotic lesions were defined by the presence of intimal lipids lying free as cholesterol clefts or in aggregates of foamy macrophages. Medial calcification was considered present when calcium crystals were observed in the tunica media (Figure 1).

TABLE 1. Baseline characteristics of study patients (N = 83)

Characteristic	Result
Age (y)	69.7 ± 8.5
Female sex	18 (21.7)
Body mass index	23.8 ± 3.3
Smoking	43 (51.8)
Diabetes	34 (40.9)
Glycated hemoglobin (%)	5.98 ± 1.14
Diet control	5 (6.0)
Oral hypoglycemic drugs	20 (24.1)
Insulin injection	9 (10.8)
Estimated glomerular filtration rate	
>60	56 (67.5)
30-60	23 (27.7)
<30	4 (4.8)
Chronic hemodialysis	1 (1.2)
Hypertension	67 (80.2)
Peripheral arterial disease	9 (10.8)
Hyperlipidemia	60 (72.3)

Values are presented as mean ± standard deviation or n (%).

Statistical Analysis

The association between preoperative risk factors and intimal hyperplasia was assessed by stepwise linear regression analysis. The following 10 clinical risk factors were included as independent variables: age, sex, body mass index, smoking, diabetes, glycated hemoglobin (HbA1c) concentration, estimated glomerular filtration rate, hypertension, peripheral arterial disease, and hyperlipidemia. Correlations between 2 continuous variables were checked using the Spearman rank correlation test. Continuous data are expressed as mean ± standard deviation and categorical data as number and percent. Univariate analysis for risk factors associated with intimal hyperplasia was performed using the Cox regression test. All variables with P values < .10 were included in a

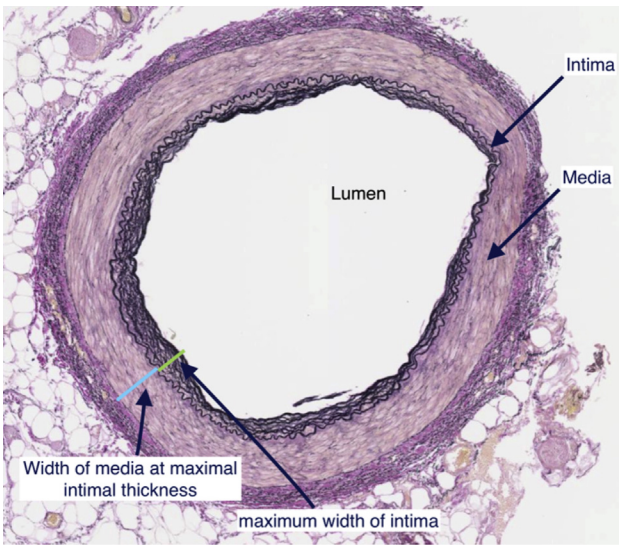

FIGURE 1. Representative gastroepiploic artery section showing indices used to evaluate severity of intimal thickness (Elastica van Gieson stain; original magnification, ×20).