

ATHEROSCLEROSIS OF THE INTERNAL MAMMARY ARTERY IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFTING

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Abstract- In patients requiring coronary artery bypass grafting (CABG), usually at least one of the internal mammary arteries is used. This study evaluates the degree of atherosclerotic involvement of the internal mammary artery (IMA) in patients undergoing CABG. During two months period, 79 patients (66 male and 13 female with a medium age of 58 years) undergoing myocardial revascularization had a biopsy of the distal left internal mammary artery. In our study atherosclerotic involvement of the IMA was assessed according to the scale of Kay. Using this index, grade 0 corresponds to a normal artery without atherosclerosis, grade 1 represents minimal disease, grade 2 a narrowing of less than 25% of the lumen, grade 3 narrowing between 25 and 50%, and grade 4 narrowing of 50% or greater of the lumen. Of the 79 IMAs examined, the arteries with degree 0, 1, 2, 3, and 4 were: 17 (21.5%), 36 (45.6%), 13 (16.5%), 10 (12.7%), and 3 (3.8%), respectively. Considering the arteries with severe atherosclerotic narrowing (3.8%), the IMA had a low but consistent incidence of atherosclerotic involvement. According to our investigation among risk factors only high blood pressure has some roles in inducing atherosclerotic changes ($p=0.014$). The other risk factors (i.e. diabetes mellitus, smoking, hyperlipidemia) had no correlation with the atherosclerotic changes in IMA. Preoperative angiography of the IMA is not necessary for all the patients that require CABG, but could be recommended in hypertensive patients.

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Key Words: Atherosclerosis, internal mammary artery, coronary artery bypass graft, angiography

INTRODUCTION

The saphenous vein graft has been the most popular graft for myocardial revascularization. The problem with it is the high rate of postoperative occlusion, which is most often due to progressive fibrous or fibromuscular intimal hyperplasia. Severe atherosclerotic changes are rare in IMA grafts (1). Currently, the IMA is generally used for coronary artery bypass grafting (CABG). The patency rate of this graft is better than that of saphenous vein grafts (2). The purpose of this study was to evaluate the degree of atherosclerotic involvement of IMA in 79 consecutive patients subjected to coronary bypass grafting.

MATERIALS AND METHODS

In this non-randomized prospective study performed from December 2001 to January 2002 in

Imam Khomeini Medical Center, Tehran University of Medical Sciences, the left IMA of 79 non-selected consecutive patients undergoing surgical coronary revascularization, was evaluated. Biopsies were obtained during surgery. The IMA was dissected as a pedicle; the distal ends were cut and sent for pathological examination. The IMA specimens were fixed in 10% formaldehyde and four transverse sections were embedded in paraffin blocks, and sectioned. These were stained with hematoxylin-eosin and for elastic fibers. Atherosclerotic involvement of the IMA was assessed using the scale of Kay and colleagues (3). This index considers the disease in terms of luminal narrowing of the IMA. The intima was defined as the distance from the lumen to the internal elastic lamella at the area of greatest internal thickness. The present scale considers 5 degrees, from 0 to 4 (0: normal artery without signs of atherosclerotic disease, 1: represents minimal disease, 2: represents narrowing of less than 25% of the lumen, 3: is a narrowing between 25% and 50%, and 4: narrowing or stenosis of 50% or more). The present risk factors associated with the development of atherosclerosis, including diabetes mellitus, hypertension, familial history of ischemic heart disease (IHD), smoking, hyperlipidemia, and obesity were obtained from

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clinical history, examination and laboratory tests. Obesity was measured by body mass index (BMI) (weight divided by the square of the height).

Statistical analysis

Continuous variables were expressed as mean \pm SD. Continuous variables were compared by means of two-tailed Student's t-tests and discrete variables were compared using the χ^2 test. For univariate predictors associated with $p < 0.1$, stepwise logistic regression analysis was performed; the odds ratio and 95% confidence interval were calculated to ascertain significant predictors of AF. Linear regression models for length of hospital stay were performed to identify important independent predictors. $P < 0.05$ was considered statistically significant.

RESULTS

All patients had coronary artery disease (CAD): one vessel disease in 6 cases (7.5%), two vessel disease in 18 cases (22.7%), three vessel diseases in 51 cases (61%), and left main disease in 7 cases (8.8%), and all of them had signs of angina pectoris according to the clinical history.

The mean of age of the patients was 58 years (range, 36 to 74 years). There were 66 men and 13 women. There was not correlation between sex and range of atherosclerosis of IMA (Fig 1). Of the 79 IMA examined, the degree of narrowing was as follows: grade 0: 17 arteries (21.5%), grade 1: 36 arteries (45.5%), grade 2: 13 arteries (16.5%), grade 3: 10 arteries (12.7%), and grade 4: 3 arteries (3.8%) (Fig 2). Macroscopic atherosclerotic lesions were found in some IMAs (Table 1).

So it is clear that although all these patients had high grade of atherosclerosis of the coronary artery that made them candidates of CABGs, only a few of them had significant atherosclerosis of IMA. The relatively high incidence of atherosclerosis of the IMA found in this report could be the result of taking the specimen from the distal part of the artery and high incidence of atherosclerosis in our country. The coronary arteries showed severe intimal thickening, progressing in severity throughout life, whereas the IMA showed no more than slight changes at any age (Fig 3). Of the known risk factors associated with the development of atherosclerosis, only hypertension correlated with the intimal thickness ($p = 0.014$). Diabetes, cigarette smoking, familial history of IHD, hyperlipidemia, and body mass index did not correlate with the intimal thickness of the IMA (Table 2) (Fig 4).

Table 1. Macroscopic finding of atherosclerosis in samples from 79 internal mammary arteries

Finding	No. of arteries
Normal	84.8%
Fatty streak	13.6%
Plaque	1.6%
Obstruction	0%

Table 2. Risk factors of IHD in patients with atherosclerotic progress in IMA

Variable	P-value
Diabetes	0.2
Familial history	0.14
Hypertension	0.014
Smoking	0.20
Hyperlipidemia	0.09
Obesity	0.2

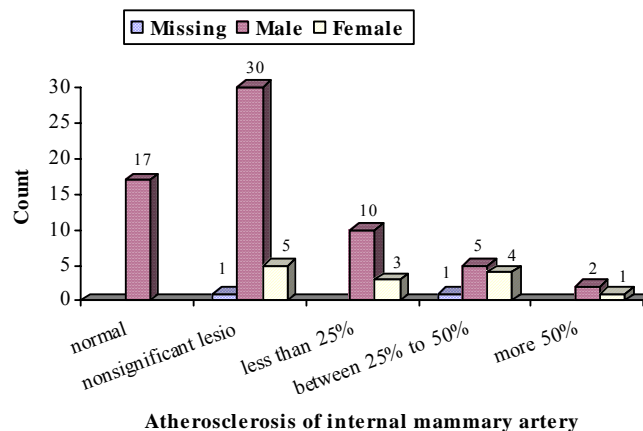


Fig. 1. The range of intimal thickening of the internal mammary artery in male and female cases

Atherosclerosis of the internal mammary artery in patients undergoing CABG

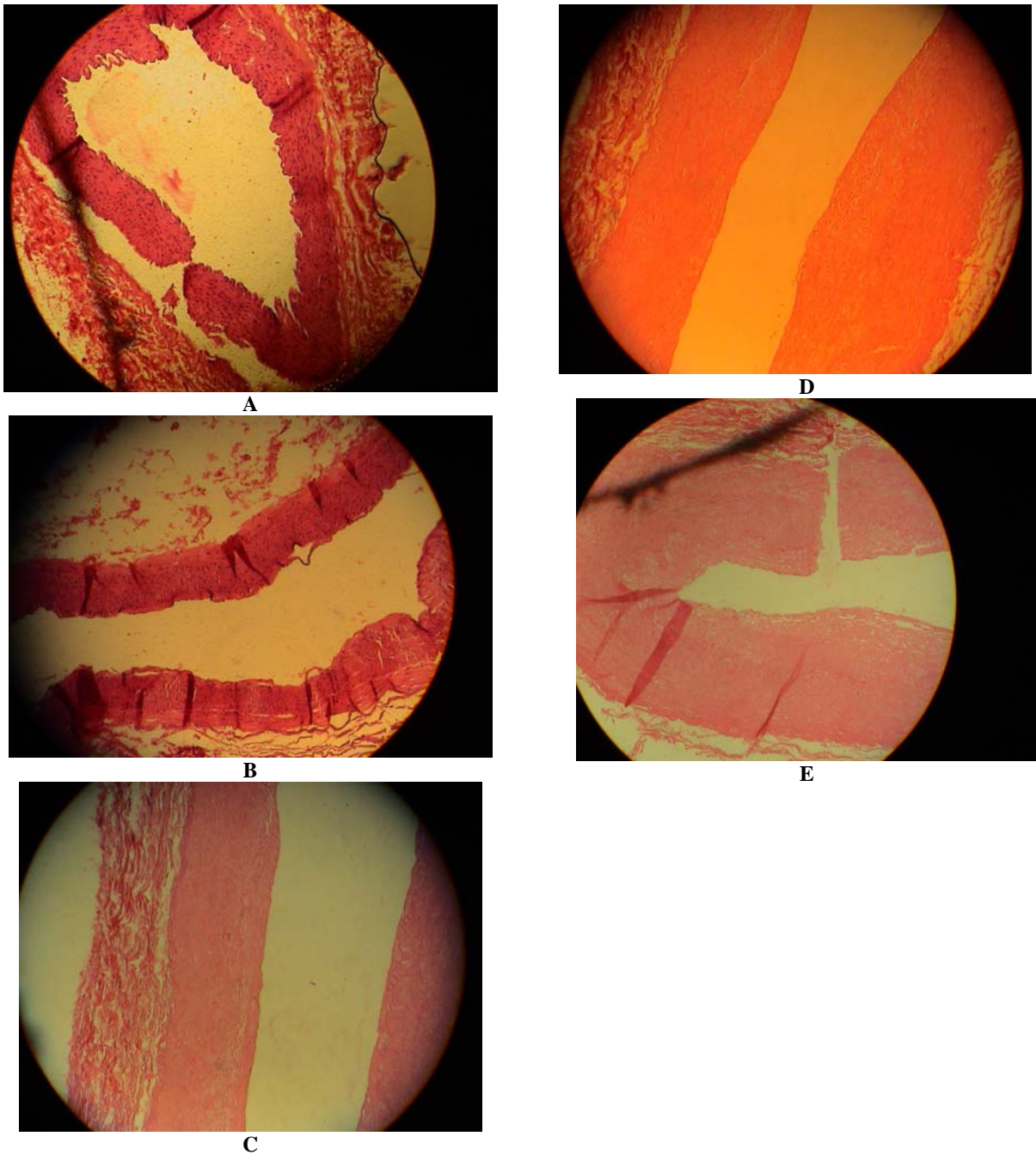


Fig. 2. Photomicrographs of the internal mammary arteries sections illustrating various grades of atherosclerosis (×100): A, grade 0. B, grade 1. C, grade 2. D, grade 3. E, grade 4

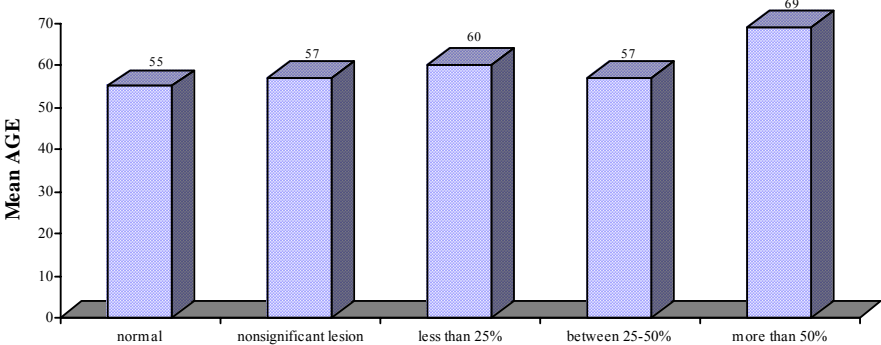
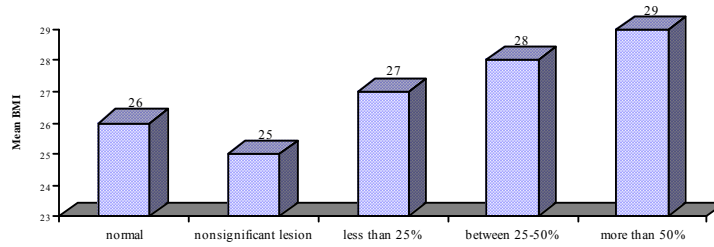
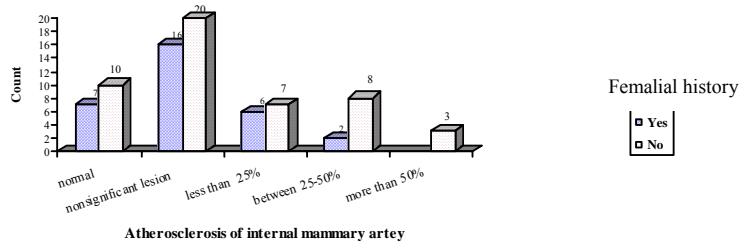


Fig. 3. The range of intimal thickening of the internal mammary artery at different ages

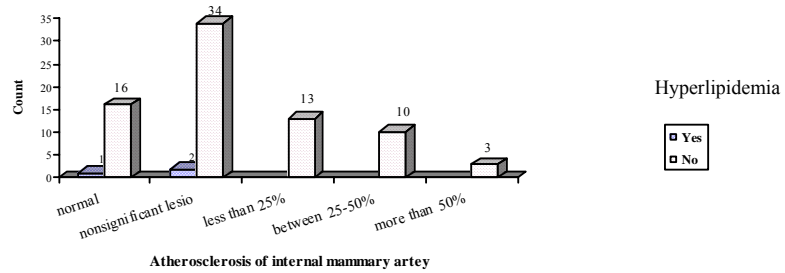
A



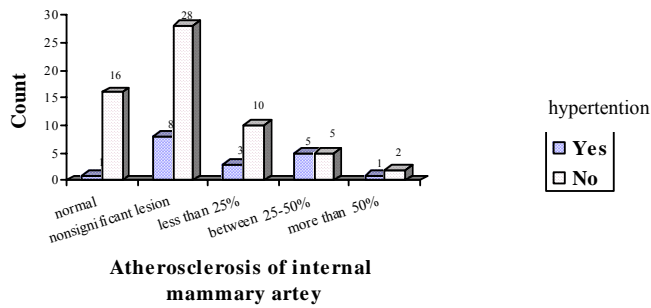
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D



E

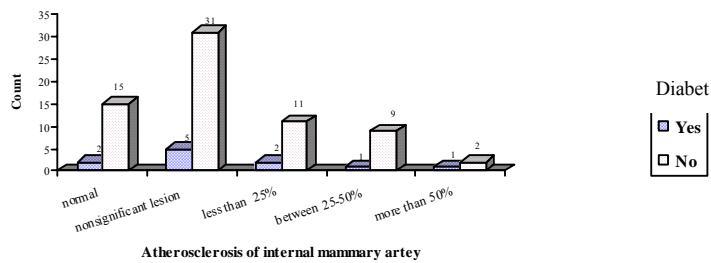


Fig. 4 A: The range of intimal thickening of the internal mammary artery and body mass index
B: The range of intimal thickening of the internal mammary artery with familial history of ischemic heart diseases
C: The range of intimal thickening of the internal mammary artery and hyperlipidemia
D: The range of intimal thickening of the internal mammary artery and hypertension
E: The range of intimal thickening of the internal mammary artery and diabetes mellitus

DISCUSSION

Atherosclerosis continues to be a lively subject of debate, and new advances are being constantly reviewed. Fundamental issues, are whether factors associated with the homogenous circulating blood, such as generalized endothelial damage, lipids, platelets, hormones, antibodies, infections, or toxins, can explain the features of arteriosclerosis in view of the specific anatomic distribution of the lesions, and the observation that certain vessels may carry blood for a whole lifetime without showing significant arterial disease (4). Coronary artery bypass grafting using the pedicle IMA is the best alternative, and renders the best results in terms of survival, quality of life, and long-term patency rate. Over the long term, there is a striking difference in the late development of atherosclerosis in IMA bypass conduits compared with venous conduits. Comparison of IMA and vein graft patency reveals a highly significant difference at every interval (5). Accelerated vein graft closure because of progressive intimal hyperplasia and phlebosclerosis begins in the fifth year and approximates 5% per year,

with a 10-year patency rate varying between 41% and 56%. In contrast, the 10-years IMA patency rate has been reported to be greater than 80% (5). It is intriguing that the IMA, a vessel comparable in cross-sectional diameter to the coronary artery and acclimated to the same arterial hemodynamics, intrathoracic respiratory pressure changes, and biochemical environment, has such a low incidence of atherosclerosis. Although the cause of the apparent protection of the IMA from intimal thickening and atherosclerosis remain obscure, a few comments can be made on the basis of accumulated evidence from research in vascular pathology (6): 1. It is an elastic artery in contrast to other arterial conduits for bypass such as the radial artery, right gastroepiploic artery and inferior epigastric artery; 2. Histologically, the IMA has no vascularization of the media from the vasa-vasorum, the nutrition is intraluminal and has more integrity of the elastic lamina; 3. The pedicle graft has a rich lymphatic network and drainage; 4. The synthesis of prostacyclin, endothelial-derived related factor and other chemical mediators; 5. Proper size matching with the coronary artery-mammary artery-arterial anastomosis shunt procedure; and 6. Flow adaptability. Therefore, the IMA has a low incidence of atherosclerosis in comparison to the coronary arteries and other arteries but is not free from atherosclerotic degeneration. Frazier and colleagues

reported three cases of severe arteriosclerosis involving the IMA in three coronary surgery patients (7). All of them were relatively young, male, with 3 vessel disease and with arterial hypertension. Kay and associates reported significant atherosclerotic narrowing in 4.2% of patients (3). Sisto and Isola found mild atherosclerosis of IMA in 11.8% of cases, and moderate atherosclerosis in 0.6% of cases in segments of IMA from 160 necropsy cases (28% with IHD), giving an overall atherosclerotic development of 12.4% (8). Sims found mild or minimal intimal thickening of the IMA in 30% of 352 necropsy examinations among adults (4). Sons and colleagues in an angiographic study of 117 patients, registered atherosclerosis of IMA in 11.1% of cases, and the majority of the changes were recorded in the proximal third of the vessel. In this study, hyperlipidemia and peripheral vascular disease were predictive factors of atheromatous disease of the IMA (9). Abad and associated, found 63.4% atherosclerotic changes in 52 specimens of IMA. Minimal lesions were found in 20 cases, arterial stenosis less than 25% in 9 cases, and 4 cases with an arterial narrowing between 25% and 50% (6). In our study, among 79 specimens of IMA, 3 cases (3.8%) showed atherosclerotic stenosis more than 50%, and 53 cases (66.6%) were normal or with minimal lesions. These studies show that CABG using the pedicle IMA remains the best choice, especially in revascularization of the left anterior descending artery. The IMA has a variable and generally low tendency for atherosclerosis. Other investigation and our study show a 2-63% of varying atherosclerotic involvement (5-9).

The extent of atherosclerotic alternations in the aorta and coronary arteries increase with age (10). In our study, obstruction of the coronary arteries increased with age, but there was not a linear positive correlation between age and all atherosclerotic alternations in the coronary arteries. There were no obstructions at all in the IMA, and the intimal thickness of this artery did not increase with age. Of the risk factors of IHD (including diabetes, smoking, hyperlipidemia) only hypertension seemed to be also a risk factor for thickening of the IMA intima. The reasons why the other risk factors do not correlate with the intimal thickness of the IMA are unknown. This study shows that arteriosclerosis in the IMA is rare even in our country with a high risk of IHD and even in patients with IHD. IMA is a protected vessel and it is relatively free from major lesions. The small degree of atherosclerosis in this series should not preclude use of the IMA for myocardial revascularization.

Therefore, preoperative angiography of the IMA is not necessary for all the patients that require CABG, but could be recommended in hypertensive patients.

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