Turkish Journal of Clinics and Laboratory

To cite this article: Mola S, Turan E, Gunertem E. Effects of left internal mammary artery (LIMA) harvesting during coronary artery by-pass grafting surgery on benign breast diseases. Turk J Clin Lab 2024; 3: 413-418

Research Article

Effects of left internal mammary artery (LIMA) harvesting during coronary artery by-pass grafting surgery on benign breast diseases

Koroner arter by-pass greftleme ameliyatı sırasında sol internal mamaryen arteri (LIMA) kullanımının benign meme lezyonları üzerine etkileri

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Abstract

Aim: Coronary artery bypass surgery of the primary conduits employed in coronary artery bypass grafting surgery (CABG) is the left internal mammary artery (LIMA), which has garnered considerable attention due to its favorable characteristics and outcomes. There are not enough studies examining the relationship between benign breast diseases (BBD) and LIMA removal. This study is one of the pioneering studies investigating the effects of LIMA removal after bypass surgery in patients with benign breast diseases. This study aims to evaluate the effect of LIMA removal on benign breast diseases in female patients undergoing bypass surgery by analyzing pre- and post-operative breast imaging.

Material and Methods: A total of 47 of 452 female patients who underwent bypass surgery between February 18, 2019, and December 31, 2021, were included in the study. All patients' LIMA were harvested and evaluated, regarding any progression of benign breast diseases.

Results: There was a significant difference between the Breast Imaging Reporting and Data System (BI-RADS) classes of the patients before and after CABG ($p<0.001$). While 40.4% of the patients were BI-RADS class 1 preoperatively, this rate decreased to 14.8% postoperatively. Class 2 level did not show a significant difference, while class 3 level increased from 8.5% to 31.9%. Correlation analysis results between pre-op and post-op BI-RADS classes and age and Body Mass Index (BMI) were analyzed, but no significant correlation value was found. The correlations between pre-op and post-op BI-RADS grades and Hormone Replacement Therapy (HRT) were significant.

Conclusion: It can be concluded that LIMA harvesting during CABG surgery in female patients affects the occurrence of BBD. The change between the pre-op and post-op period was determined by mammography tests. It was shown that there was a significant change in BI-RADS scores on mammography after bypass surgery.

Keywords: Left internal mammary artery, coronary artery bypass grafting, benign breast diseases, BI-RADS, mammography

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Recevied: 16.07.2024 accepted: 02.09.2024

Öz

Amaç: Koroner arter bypass cerrahisinde (KABG) olumlu özellikleri ve sonuçları nedeniyle en büyük ilgi gören ve en çok kullanılan graft sol internal mamaryen arterdir. (LIMA). KABG olan hastadalardaki iyi huylu meme hastalıkları (BBD) ile LIMA'nın kullanılması arasındaki ilişkiyi inceleyen yeterli çalışma yoktur. Bu çalışma benign meme hastalıkları olan hastalarda bypass ameliyatı sırasında LIMA çıkarılmasının etkilerini araştıran öncü çalışmalardan biridir. Bu çalışma, bypass ameliyatı geçiren kadın hastalarda ameliyat öncesi ve sonrası meme görüntüleme yöntemlerini analiz ederek LIMA çıkarılmasının iyi huylu meme hastalıkları üzerindeki etkisini değerlendirmeyi amaçlamaktadır.

Gereç ve Yöntemler: Çalışmaya 18 Şubat 2019 ile 31 Aralık 2021 tarihleri arasında KABG geçiren 452 kadın hastadan 47'si dahil edildi. Tüm hastalarda LIMA kullanıldı, bu hastalardaki iyi huylu meme hastalıklarının değişimi değerlendirildi.

Bulgular: Hastaların KABG öncesi ve sonrası Meme Görüntüleme Raporlama ve Veri Sistemi (BI-RADS) sınıfları arasında anlamlı fark vardı (p<0,001). Ameliyat öncesi hastaların %40,4'ü BI-RADS sınıf 1 iken ameliyat sonrası bu oran %14,8'e düştü. 2. sınıf düzeyi önemli bir fark göstermezken, 3. sınıf düzeyi %8,5'ten %31,9'a yükseldi. Ameliyat öncesi ve sonrası BI-RADS sınıfları ile yaş ve Beden Kitle İndeksi (BKİ) arasındaki korelasyon analizi sonuçları analiz edildi ancak anlamlı bir korelasyon saptanmadı. Ameliyat öncesi ve sonrası BI-RADS dereceleri ile Hormon Replasman Tedavisi (HRT) arasındaki korelasyonlar anlamlıydı.

Sonuç: Kadın hastalarda KABG ameliyatı sırasında LIMA kullanımının BBD oluşumunu etkilediği sonucuna varılabilir. Mamografi ile takip edilen hastalarda ameliyat öncesi ve sonrası dönem karşılaştırıldığında lezyonlarda değişim olduğunu belirlenedi. Bypass ameliyatı sonrası mamografide BI-RADS skorlarında anlamlı değişiklik olduğu gösterildi.

Anahtar Kelimeler: sol internal mamaryen arter, koroner arter bypass greftleme, benign meme lezyonları, BI-RADS, mamograf

Introduction

CABG remains a cornerstone in the treatment of coronary artery disease, aiming to alleviate angina, improve quality of life, and reduce the risk of myocardial infarction (1–3). Among the various surgical techniques and strategies, the use of grafts plays a crucial role in rerouting blood flow around narrowed or blocked coronary arteries. One of the primary conduits employed in CABG is the LIMA, which has garnered considerable attention due to its favorable characteristics and outcomes (4,5).

Good knowledge of breast anatomy is critical to perform safe breast operations on patients and breast tissue, which consists of only adipose tissue in men and skin, fat, fascia layers, Cooper ligaments, fibroglandular tissue, and lymphatics in women, is located on the chest wall. The internal thoracic artery (internal mammary artery, IMA) is the main arterial perfusion vessel in the breast tissue, where blood vessel density is at its most extreme and perfusion depends on physiologic activity and parenchymal volume, such as during pregnancy or lactation (6). The LIMA emerges from the subclavian artery and descends along the chest wall, running parallel to the sternum. (7,8). Women continue to have greater rates of operative death after coronary artery bypass grafting and a worse long-term prognosis than men. Surgeons are under pressure to determine the optimal surgical approach to enhance the long-term success of coronary bypass grafting for women in light of these findings (9).

BBD includes all non-malignant pathologic conditions of the breast, including proliferative and nonproliferative disorders, associated with infection and inflammation, and often do not carry a progressive malignant condition. Mastitis, abscess, Mondor disease, fat necrosis, breast cysts, duct ectasia, mild hyperplasia, fibroadenoma, sclerosing adenosis, papillomas, and nipple discharge are benign conditions that can develop in women (10,11).

Among women screened for breast cancer, women with prominent mammographic findings, such as architectural distortion, multiple findings, asymmetries, and calcifications, were found to have a higher risk of breast cancer than women with masses; a linear trend between BBD and cancer diagnosis has been reported, with 50% of breast cancers occurring within 5 years of BBD diagnosis (12,13).

The standard technique involves harvesting the LIMA from its origin in the chest wall, preserving its intact pedicle, and minimizing trauma to the arterial wall. Subsequently, the LIMA is anastomosed to the LAD (Left anterior descending) artery beyond the site of stenosis, ensuring optimal blood flow to the jeopardized myocardium (13,14).

It is unclear how arterial revascularization affects long-term outcomes when compared to men. Since the LIMA is the most important artery supplying the breast in women, any traumas in the chest region after bypass grafting surgery may trigger benign breast diseases. Although there have been some

studies on the effect of LIMA on gender-based in-hospital outcomes after bypass graft, the effects of LIMA harvesting on chest diseases have not yet been investigated. Moreover, although there are studies on the status and effect of IMA in patients with breast cancer, there are not enough studies on benign breast diseases (16–19).

This study aims to evaluate the effects of LIMA harvesting on benign breast diseases in female patients undergoing bypass surgery by analyzing preoperative and postoperative breast imaging.

Material and Methods

A total of 452 female patients who underwent CABG operation with harvesting the LIMA at Ankara Bilkent City Hospital Cardiovascular Surgery Clinics between February 18, 2019, and December 31, 2021, were included in the study. However, only 47 of these patients with preoperative and postoperative mammograms were available regarding any progression of benign breast diseases. Power Analysis was applied to determine the number of patients using the Simple Random Sampling method. Power Analysis was performed with GPower 3.1.9.6 (Universitaet Kiel, Germany). "Exact" was selected as the test family and "Proportion: Sign test (Binomial test)" was selected as the analysis. The sample size was calculated as n=38 for a Type-I margin of error of 0.05, power of 95%, estimated odds ratio of p=0.12, and effect size of d=0.10. Accordingly, it was decided that n=47 patients would be sufficient for the study. Ethical approval of the study was obtained from Ankara Bilkent City Hospital Clinical Research Ethics Committee No. 1 with the approval dated 16/08/2022 and numbered E1-23-3684.

A total of 452 female patients who underwent CABG operations in our clinic were included in the study. However, only 47 of these patients with preoperative and postoperative mammograms were available. Power Analysis was applied to determine the number of patients using the Simple Random Sampling method. Power Analysis was performed with GPower 3.1.9.6 (Universitaet Kiel, Germany). "Exact" was selected as the test family and "Proportion: Sign test (Binomial test)" was selected as the analysis. The sample size was calculated as n=38 for a Type-I margin of error of 0.05, power of 95%, estimated odds ratio of p=0.12, and effect size of d=0.10. Accordingly, it was decided that n=47 patients would be sufficient for the study.

Radiological Protocol

Mammography images were assessed as the imaging modality. The presence of mammograms taken one year before and following the procedure was considered to exclude potential confounding factors that may have arisen during the interim period.

After the evaluation, two radiology specialists classified the condition of the breast according to a well-known classification method. This classification called BI-RADS (Breast Imaging Reporting and Data System) is used in breast imaging reports (20).

BIRADS Classification:

Category 0: Additional imaging methods are needed

Category 1: Normal findings

Category 2: Definitely benign findings

Category 3: Probably benign findings

Category 4: Suspicious findings

Category 5: High probability of malignant findings

Category 6: Patients with breast cancer detected by biopsy

Surgical Protocol

The LIMA was prepared as a graft for all patients undergoing coronary artery bypass surgery. Following median sternotomy, the IMA retractor (The original name is IMA Couëtil Sternal Retractor) was positioned, and the left parietal pleura was dissected. The artery was prepared for pedicle use utilizing the LIMA no-touch technique, which involves dissection through the endothoracic fascia. Intercostal arteries are ligated and separated using cautery assistance. The LIMA is dissected from its distal portion, and pulsatile bleeding is assessed. If bleeding exceeds 30 mL/min, the artery is temporarily preserved between the pericardium and the lung with a hot gauze soaked with papaverine, for subsequent use as a graft (Figure 1).

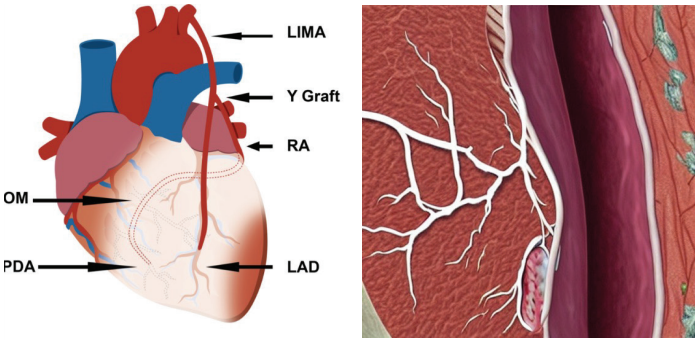

Figure 1. LIMA graft configuration during by-pass surgery

Statistical Analysis

The statistical analyses were performed by SPSS 27.0 (IBM Inc, Armonk, USA) software. The descriptive statistics were presented as mean±SD for numerical variables and frequency (percentage) for categorical variables. Pre-op and post-op BI-RADS scores were

compared with ordinal statistical tests such as the McNmear-Bowker test, Kendall's Tau-b, Somer's d, and Gamma tests. The inter-observer agreement was determined by using Kenall's tau-b and Somer's d also. The p<0.05 was considered as a statistically significant result accepting type-I error as 5%.

Results

A total of 47 patients were included in the study. The mean age of the patients was 58.3±8.2 years. They were generally classified as overweight with a mean Body Mass Index (BMI) of 27.7±3.2 kg/m2. Most of the patients had comorbidities such as Diabetes Mellitus (DM) (70.2%) and Hypertension (HT) (53.1%). Only 17% of the patients had received HRT. The mean length of stay in the intensive care unit was 18.5±28.5 hours and the mean length of hospitalization was 5.7±2.2 days (Table 1).

Table 1. Patient Characteristics and Demographical Data

Total count (n)	47
Age (mean, SD), year	58.3±8.2
BMI (mean, SD), kg/m2	27.7±3.2
HRT (n, %)	8 (17%)
Diabetes Mellitus (n, %)	33 (70.2%)
Hypertension (n, %)	25 (53.1%)
Smoking (n, %)	30 (63.8%)
CABG, anastomosis (mean, SD)	3.4±2.3
CPB time (mean, SD), min	96.5±32.1
Cross-clamp time (mean, SD), min	62.7±28.7
Operation time (mean, SD), min	247.5±104.2
ICU stay (mean, SD), hour	18.5±28.5
Hospital stay (mean, SD), day	5.7±2.2

(BMI: Body Mass Index kg/m2, HRT: Hormone replacement therapy, CABG: Coronary artery bypass grafting, CPB: Cardiopulmonary bypass, ICU: Intensive care unit)

There was a significant difference between the BI-RADS classes of the patients before and after CABG (p<0.001). While 40.4% of the patients were BI-RADS class 1 preoperatively, this rate decreased to 14.8% postoperatively. Class 2 level did not show a significant difference, while class 3 level increased from 8.5% to 31.9% (Table 2) (Figure 2). Correlation analysis results between pre-op and post-op BI-RADS classes and age and BMI were analyzed, but no significant correlation value was found. The correlations between pre-op and post-op BI-RADS grades and HRT were significant. Among the pre-op BI-RADS levels, only level 3 was significantly associated with HRT (p=0.001). All patients at level 3 had received HRT. In post-op BI-RADS levels, levels 2 and 3 were associated with HRT (p<0.001). All patients at level 2 did not receive HRT, while all patients who received HRT were at level 3.

Table 2. Pre-op and post-op BI-RADS classes

	Post-op BI-RADS			
Pre-op BI_RADS	N (%)	N (%)	N (%)	
	1	2	3	Total
1	7 (100.0)	10 (40.0)	2 (13.3)	19 (40.4)
2	0	15 (60.0)	9 (60.0)	24 (51.1)
3	0	0	4 (26.7)	4 (8.5)
Total	7 (14.8)	25 (53.1)	15 (32.1)	47
	Test Statistics	p		
McNemar-Bowker	21.0	<0.001		
Somer's d	0.555	<0.001		
Kendall's Tau-b	0.555	<0.001		
Gamma	0.856	<0.001		

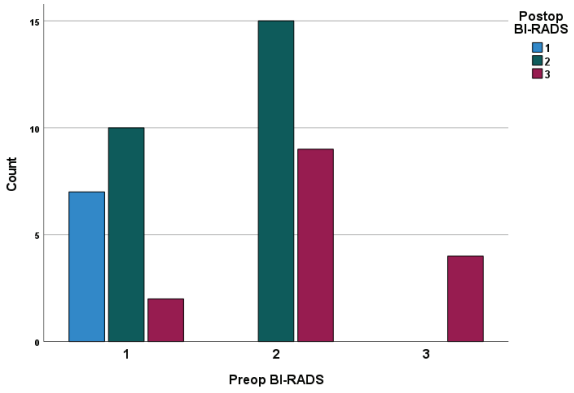

Figure 2. Pre-op and Post-op BI-RADS classification levels

Discussion

Although there are many publications on LIMA removal in the literature on tire and cardiovascular surgery, according to our research, there are not enough studies examining the relationship between benign breast diseases and LIMA removal. This study is one of the pioneering studies investigating the effects of LIMA removal after bypass surgery in patients with benign breast diseases. Therefore, the results of LIMA removal have not been adequately discussed. In our study, there was a significant change in BI-RADS scores on mammography after bypass surgery. BMI values showed that the patients were prone to obesity. The majority had comorbid diseases. LIMA is considered the standard vessel for coronary artery bypass grafting. However, in recent years, numerous studies have demonstrated the importance of LIMA as an endocrine organ with extracellular vesicles known as exosomes in cardiovascular signaling and various pathological conditions (21). BI-RADS levels appear to be associated with HRT uptake. It is not clear how LIMA inference, which is so important, affects outcomes in patients with BBD.

The blood vessel supply to the breast is inferred from branches of the inner thoracic (mammary) course, intercostal supply routes, and the horizontal thoracic course. The venous life systems of the breast parallel the blood vessel life systems within the profound breast tissues, with matched blood vessels and venous branches seen with back intercostal, axillary, and inside thoracic (mammary) vascular pathways. When shallow veins deplete centrally, they more often than not merge on a periareolar circular arrange of veins (circulus venosus of Haller); from this venous plexus, venous blood is channeled into the inside thoracic veins medially and into the sidelong thoracic veins along the side (6).

In a study, it was evaluated IMAs in patients with malignant breast tumors and patients with no breast lesions. The frequencies of IMA anastomoses were not significantly different between patients with and without malignant breast lesions. This phenomenon might also explain contralateral breast metastases that are observed in 10% to 15% of patients 15 years after treatment and even the higher proportion of longer-term survivors (16).

In a case report, it was reported that the left IMA was harvested to create a LIMA bypass graft, resulting in the loss of the perforator branches medially. The lateral thoracic and thoracoacromial arteries, among other axillary branches, are severely attenuated and impacted by extended lengths of calcified atherosclerosis. However, detectable extended stretches of linear calcification traversing the breast tissue provide evidence in favor of small vessel angina. This is thought to have had a part in the necrosis spreading to the right breast's medial side (22).

Although the LIMA graft is most commonly linked to cardiovascular surgery, it has a wide range of applications in plastic surgery in addition to CABG. Plastic surgeons have come to understand the special qualities of LIMA grafts and how they can be used to solve difficult reconstructive problems while also improving aesthetic results and patient satisfaction. The growing significance of LIMA grafts in plastic surgery highlights its ground-breaking uses and revolutionary impact (23). The LIMA transplant is a cornerstone procedure in cardiovascular surgery that provides patients with coronary artery disease (CAD) with hope and healing (24,25).

There are some limitations in our study. First of all, the sample size of the study was small. There were not enough patients with a diagnosis of BBD who needed bypass surgery. Therefore, data were collected to find patients who met the inclusion criteria. Another limitation of the retrospective study is that there were patient files with deficiencies during data analysis and these files could not be included in the study.

In future studies, randomized controlled trials with larger samples will be conducted to reach better levels of evidence.

It can be concluded that the left internal mammary artery graft stands as a paragon of excellence in cardiovascular surgery, embodying the convergence of scientific innovation, surgical skills, and patient-centered care. The utilization of the left internal mammary artery as a graft in coronary artery bypass surgery represents a cornerstone of modern revascularization strategies. Harvesting of LIMA is not a commonly discussed procedure in relation to benign breast diseases. However, in certain cases where there are benign breast conditions like fibroadenomas or benign breast cysts, the BI-RADS scores show that there is a significant change before and after the LIMA harvesting during the bypass surgery.

Conflict of Interest

The authors declare that there is no conflict of interest in this study.

Financial Disclosure

This study was prepared by no means of any funding or grant, and the authors declare that there is no financial disclosure

Author Contribution

Conceptualization: SM

Design: SM

Data collection and processing: SM, ET

Literatur review and Texting: SM, ET

Analysis and Results: SM, ET

Approval: ET

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