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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

Comparison of endoscopic versus conventional internal mammary harvesting regarding unligated side branches

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Abstract

Background: In an effort to minimise access in cardiac surgery, endoscopic vessel harvesting has become more popular. The endoscopic approach, however, allows for only the harvest of the mid to distal internal mammary artery (IMA), leaving the more proximal branches of the conduit available for collateral flow away from the coronary bed.

Aim: To compare the number and anatomic variation of remaining side branches in thoracoscopic vs. conventional IMA harvesting.

Methods: 199 fresh cadavers were randomly divided into two groups. Group A (n = 100) underwent endoscopic IMA harvesting. In Group B (n = 99), IMAs were harvested using an open conventional approach. In both groups during surgery, side branches of the IMA were isolated and identified.

Results: The two groups were comparable with regard to mean age and age distribution, male sex (56% vs. 63%, respectively), cause of death and coronary risk factors including smoking, diabetes, dyslipidaemia and hypertension. 24 of 199 cadavers (12%) had a lateral costal branch. The left IMA arose from the third part of the subclavian artery in 6%, and from the thyrocervical trunk in 7% of the cadavers. There were significantly more unligated side branches in Group B compared to Group A (14 branches vs. 3 branches, $p < 0.01$). The first intercostal artery and lateral costal artery were found unligated in 3% and 5% of cadavers in Group B, whereas no side branch remained unligated in Group A. There was no subclavian artery or IMA injury in either group. Internal mammary vein was damaged in 2% of cadavers in Group B.

Conclusions: Thoracoscopic left IMA harvesting is more accurate in finding and ligating the side branches of IMA.

Key words: internal mammary artery, cadaver, thoracoscopy

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INTRODUCTION

Coronary artery bypass grafting (CABG) is considered to be the treatment of choice in many patients with multivessel coronary artery disease involvement or left main coronary disease and its effectiveness has been confirmed by many studies [1, 2]. The choice of conduit used in CABG has evolved over the years. At present, the internal mammary artery (IMA) is the preferred conduit for myocardial surgical revascularisation because of its excellent long-term patency rate. In addition to better graft patency, the use of IMA grafts as a vascular conduit also improves long-term survival, lowers rates of preoperative cerebrovascular accidents, and reduces in-hospital operative mortality [3–5].

Standard CABG, however, is associated with significant invasiveness and large social, direct, and indirect costs [6]. In an effort to minimise access in cardiac surgery, endoscopic approaches have developed over the past decade, aiming to reduce the morbidity associated with the procedure, while preserving the quality of the conduit and anastomosis. Several potential advantages of less invasive techniques,

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such as better cosmetic results, reduced trauma and shorter recovery times, have been reported [7–9]. Nevertheless, the emergence of minimally invasive CABG, which limits the surgeon's ability to ligate proximal branches, has attracted renewed attention to left internal mammary artery (LIMA) side branches as a cause of coronary 'steal' [10, 11]. Coronary steal syndrome is a rare cause of postoperative angina, which is caused by a proximal subclavian artery stenosis or flow diversion in anomalous or large unligated side branches of the LIMA [12]. The LIMA branches are surgically ligated before performing bypass grafting [13]. However, some side branches might be unligated because of minimal invasive procedures or anatomical variants.

The aim of this study was to compare the number and anatomic variation of remaining side branches in thoracoscopic versus conventional open LIMA (open) harvesting.

METHODS

The experimental protocol of this study was approved by the Committee of Human Subject Research and Body Donation of the Tehran University of Medical Sciences. 199 fresh cadavers were used for the experiments. The cadavers were randomly divided into two groups. Group A (n = 100) underwent endoscopic IMA harvesting. In Group B (n = 99), IMAs were harvested using an open conventional approach. All operations were performed by one surgeon.

Endoscopic surgery technique

The subject was positioned on the operating table in a 30° right lateral decubitus position with the right arm elevated above the head. A 1 cm incision was made in the fifth intercostal space in the mid-auxiliary line for the thoracoscope. Instrument ports were then inserted through the third and sixth intercostal spaces on the anterior axillary line under thoracoscopic vision. The IMA was localised, and the endothoracic fascia and transverse thoracic muscle were removed from the IMA pedicle to adequately visualise the vessel. The pericardial fat pad was removed from the pericardium using electrocautery. The LIMA was dissected from the origin to the sixth rib as a pedicle under secondary visualisation using low voltage electrocautery and surgical clips. Dissection of the LIMA was started proximally with progression of the dissection toward the sixth rib. After harvesting the vessel, the subject was placed in the supine position and side branches were identified and clipped or cauterised.

Conventional surgery technique

The conventional LIMA harvesting was done by opening the cadaver's chest with a midsternotomy incision. Once the chest had been opened and retracted, the left hemisternum was elevated with a special LIMA retractor (Geister Company, Tuttlingen, Germany) and the IMA was harvested. After harvesting the vessel, the subject was placed in the supine position and all side branches were identified before being clipped or cauterised.

Table 1. Cadaver characteristics

Characteristics	Thoracoscopic harvesting	Conventional harvesting	P
Age [years]	45.3	48.5	NS
Female	47	44	NS
Smoking	24%	23%	NS
Diabetes mellitus	12%	11%	NS
Dyslipidaemia	9%	13%	NS
Hypertension	15%	18%	NS
Cause of death:			NS
Trauma	25%	20%	NS
Cancer	35%	30%	NS
Toxicity	5%	7%	NS
Infection	6%	8%	NS
Cardiovascular	17%	21%	NS
Cerebrovascular	12%	14%	NS

Statistical analysis

Numerical variables were compared by means of Student's t-test for normally distributed data and Mann-Whitney for non-parametric data. Categorical data was compared by means of χ^2 or Fishers Exact tests. Statistical analysis of data was performed using SPSS 18. P values < 0.05 were considered statistically significant

RESULTS

Cadaver characteristics are detailed in Table 1. Overall, 54.5% of the cadavers were male (56% in Group A, 63% in Group B). Subjects operated in the thoracoscopic group were slightly, but not significantly, younger (45.3 vs. 48.5 years). The two groups were comparable with regard to mean age and age distribution, male sex (56% vs. 63%, respectively), cause of death and coronary risk factors including smoking, diabetes, dyslipidaemia and hypertension.

Table 2 summarises the anatomic variation of LIMA in both groups. 24 of 199 cadavers (12%) had a lateral costal branch. The LIMA arose from the third part of the subclavian artery in 6%, and from the thyrocervical trunk in 7% of the cadavers.

As depicted in Table 3, with regard to remaining LIMA side branches after the surgery, there were a significantly higher number of unligated side branches in Group B compared to Group A (14 branches vs. 3 branches, p < 0.01). The first intercostal artery and lateral costal artery were found unligated in 3% and 5% of cadavers in Group B, whereas no side branch remained unligated in Group A. There was no subclavian artery or IMA injury in either group. Internal mammary vein was damaged in 2% of cadavers in Group B.

Table 2. Anatomic variations of left internal mammary artery

Anatomic variation	Thoracoscopic harvesting	Conventional harvesting	P
Lateral costal artery	13%	11%	NS
IMA from 3rd part of SCA	5%	7%	NS
IMA from thyrocervical trunk	5%	6%	NS
Short IMA	4%	3%	NS
Intrathymic IMA	4%	2%	NS

Bifurcation before fifth intercostal space; IMA — internal mammary artery; SCA — subclavian artery

Table 3. Unligated side branches in cadavers after vessel harvesting

Unligated side branch	Thoracoscopic harvesting	Conventional harvesting	P
First intercostal artery	0	3	NS
Lateral costal artery	0	5	0.01
Thymic artery	2	2	NS
Pericardiaco-phrenic artery	1	4	NS
Total	3	14	0.004

DISCUSSION

LIMA is considered to be the conduit of choice for coronary revascularisation of the left anterior descending artery because of favourable long-term patency rates [14]. Despite overall excellent patency rates, the use of the LIMA is not without problems. One potential cause of recurrent symptoms can be a chest wall branch causing flow 'steal'. Coronary artery steal syndrome is not rare and is associated with a recurrence of angina [11]. Many causes have been considered, including subclavian artery stenosis, coronary-pulmonary fistulas, arterio-venous fistulas, and LIMA graft side branches [15, 16].

IMA arises from the thoracic part of the subclavian artery, just opposite to the thyrocervical trunk and medial to the scalenus anterior. IMA may also branch off from the cervical part of the subclavian artery [17]. Occasionally, the IMA can have a common origin with the thyrocervical trunk, thyroid artery or costocervical trunk [18]. It travels downward on the inside of the ribcage until it divides into the musculophrenic artery and the superior epigastric artery around the sixth intercostal space. IMA characteristically gives rise to a number of branches, including the pericardiacophrenic, anterior intercostal, thymic, and perforating vessels [18, 19]. The pericardiacophrenic branch arises from the initial part of the IMA. In its run off, the artery accompanies the phrenic nerve and runs toward the diaphragm, where it anastomoses with the musculophrenic and inferior phrenic arteries [19]. The thymic branch is a thin artery that branches off at the level of the first intercostal space. The lateral thoracic artery is a rare branch that arises from the initial part of the IMA. In our study, the lateral costal artery was found in 12% of cadavers, which is similar to results reported by Luise et al. [20].

LIMA side branches to the chest wall are common, occurring in 9–25% of patients who have undergone CABG surgery [12, 21]. Furthermore, almost 10% of LIMA grafts may possess large side branches [22]. The presence of a large side branch, such as lateral costal artery, raises concern that blood flow could be diverted away from the anastomosis. This argument for a coronary steal phenomenon as a cause of post-CABG angina has been raised by many studies.

In a study by Singh and Sosa [12], 20 (25%) symptomatic patients with IMA grafts were found to have unusually enlarged side branches on arteriographic studies. One had a large lateral costal branch and four had large pericardial branches with collaterals draining into the pulmonary circulation. Abdo et al. [23] demonstrated that thoracic side branches could lead to coronary steal by proving objective ischaemia in radionuclide studies. Hartz and Heuser [24] described a case of IMA flow steal with ischaemia documented on a thallium study that resolved after coil obliteration both clinically and by the normalisation of the nuclear test. Moreover, a number of case reports have documented successful attenuation of anginal symptoms following termination of blood flow in the culprit side branches [25–27].

In an effort to minimise access in cardiac surgery, endoscopic approaches have become more popular. Among the potential advantages of endoscopic harvesting of the conduit are reduction of trauma, better cosmetic results, and faster recovery. Despite its substantial benefits, the endoscopic approach is disliked by many surgeons because of its presumed less access to the most proximal part of the LIMA, raising the concern of neglected and unligated side branches. Thus, there are concerns about the more proximal branches of the conduit which are available for collateral flow away from the coronary bed. However, in our study, we found that there were significantly fewer unligated branches in the endoscopic group. There was also less injury to adjacent vascular organs in the endoscopy group, although this was not statistically significant.

CONCLUSIONS

Thoracoscopic LIMA harvesting is more accurate in finding and ligating the side branches of IMA. The clinical application of these results should be supported by large scale angiography.

Conflict of interest: *none declared*

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Porównanie liczby niepodwiązanych gałęzi bocznych w przypadku pobierania tętnicy piersiowej wewnętrznej metodami endoskopową i tradycyjną

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Streszczenie

Wstęp: W związku z ograniczaniem dostępu kardiochirurgicznego coraz bardziej popularne staje się endoskopowe pobieranie naczyń krwionośnych. Metoda endoskopowa umożliwia jednak pobieranie tylko środkowego lub dalszego odcinka tętnicy piersiowej wewnętrznej (IMA), pozostawiając położone proksymalnie gałęzie konduitu dostępne dla krążenia obocznego poza łożyskiem wieńcowym.

Cel: Celem niniejszego badania było porównanie liczby i zmienności anatomicznej pozostałych gałęzi bocznych w przypadku pobierania IMA metodą torakoskopii i tradycyjną metodą otwartą.

Metody: Na dwie grupy losowo podzielono 199 świeżych zwłok. W grupie A (n = 100) pobrano IMA endoskopowo, a w grupie B (n = 99) do pobrania IMA zastosowano tradycyjną metodę otwartą. W obu grupach podczas zabiegu wyizolowano i zidentyfikowano boczne gałęzie IMA.

Wyniki: Grupy A i B były porównywalne pod względem średniej wieku i rozkładu płci (mężczyźni stanowili odpowiednio 56% i 63%), przyczyny zgonu i czynników ryzyka wieńcowego, takich jak palenie tytoniu, cukrzyca, dyslipidemia i nadciśnienie tętnicze. W przypadku 24 spośród 199 zwłok (12%) stwierdzono występowanie bocznej gałęzi żebrowej. Lewa tętnica piersiowa wewnętrzna (LIMA) odchodziła od trzeciej części tętnicy podobojczykowej u 6% osób i od pnia tarczowo-szyjnego u 7% osób. W grupie B stwierdzono istotnie więcej niepodwiązanych gałęzi bocznych niż w grupie A (odpowiednio 14 gałęzi i 3 gałęzie; p < 0,01). Pierwsza tętnica międzyżebrowa i tętnica żebrowa boczna były niepodwiązane w przypadku 3% i 5% zwłok w grupie B, natomiast w grupie A nie stwierdzono ani jednego przypadku niepodwiązania tych naczyń. W żadnej z grup nie doszło do uszkodzenia tętnicy podobojczykowej ani piersiowej wewnętrznej. Żyła piersiowa wewnętrzna była uszkodzona w przypadku 2% zwłok w grupie B.

Wnioski: Zastosowanie torakoskopii do pobierania LIMA ułatwia znalezienie i podwiązanie bocznych gałęzi tętnicy piersiowej wewnętrznej.

Słowa kluczowe: tętnica piersiowa wewnętrzna, zwłoki, torakoskopia

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