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Original Article

Extrapleural Harvesting of the Internal Thoracic Artery – Impact on Early Postoperative Results and Pulmonary Function

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Abstract

Introduction: The internal thoracic artery (ITA) has proven to be the best graft for surgical myocardial revascularization, especially in the configuration left ITA (LITA) to the anterior descending branch of left coronary artery (LAD). Its harvesting is usually accompanied by pleurotomy, followed by drainage tube placement into the pleural cavity, using the so called intrapleural method. Extrapleural technique for LITA harvesting is also practiced in many cardiac surgery centers and with this technique the pleura is left intact.

Aim: The aim of our study was to investigate the impact of both techniques of LITA harvesting on lung function and incidence of postoperative complications early after operation.

Materials and methods: We analyzed retrospectively data of 82 operated patients scheduled for surgical myocardial revascularization and meeting certain inclusion and exclusion criteria. The patients were divided into two groups depending on the way LITA was prepared. Lung parameters and incidence of surgical complications were registered in the early postoperative period until day 30.

Results: The patients from both groups had similar preoperative characteristics and risk factors. Those with preserved pleura showed significantly better results of the studied pulmonary parameters and lower complications event rate during early postoperative follow-up.

Conclusions: Maintaining the pleura integrity during LITA harvesting is beneficial for lung function and reduces the rate of complications in the early postoperative period.

Keywords

coronary artery bypass graft, internal thoracic artery, pleural cavity, pulmonary function

INTRODUCTION

The internal thoracic artery (ITA) is a perfect graft for surgical myocardial revascularization, especially the left one (LITA) in configuration to the anterior descending branch of the left coronary artery (LAD).[1] With regard to the pleural cavity, the LITA harvesting techniques are two types. The first one is when the dissection includes pleurotomy – the intrapleural technique, and second one when the integrity of the pleural cavity is preserved – the extrapleural technique.[2] Complications associated with arterial harvesting may affect postoperative morbidity and mortality.[3] Most candidates for coronary surgery have initially impaired lung function, mainly due to smoking. The combination of this predisposition with the adverse effects of extracorporeal circulation exponentially increases the risk of atelectasis and inflammatory complications in the early postoperative period.[4]

AIM

The aim of our study was to investigate the impact of maintaining the pleura integrity during ITA harvesting on lung function and the incidence of postoperative complications until day 30.

MATERIALS AND METHODS

The study is retrospective, conducted at St Ekaterina University Hospital in Sofia. We analyzed data of 82 patients scheduled for coronary artery bypass surgery in the period from July to December 2020 who met certain inclusion and exclusion criteria **(Table 1)**.

The patients were divided into two groups by the surgical technique used for LITA harvesting. Group 1 included 38 patients in whom the extrapleural technique was used. Group 2 was 44 patients in whom we used the intrapleural approach. To find the level of comparability between groups, ten risk factors and demographic characteristics were registered with a predictive value for lung function **(Table 2)**.

The groups were compared using the following indicators: 1) presence of atelectasis and pleural effusions more than 600 ml (found both on X-rays and transthoracic ultrasound performed on postoperative days 1, 5, and 30; 2) total bleeding in milliliters until drainage tube was removed; 3) time to extubation in hours; 4) need for catecholamine maintenance; and 5) values of oxygen partial pressure, carbon dioxide and arterial saturation from blood gas analyses performed at 1, 12, and 36 hours **(Table 3)**. Lung parameters and incidence of surgical complications were followed up in the early postoperative period for 30 days.

Surgical techniques

In all patients included in the study, only LITA is used as a graft to LAD. Other grafts for bypasses are conduits of great saphenous vein. After a midsternal longitudinal incision is made, the posterior surface of the sternum and ribs are exposed using special self-retaining retractor (Couëtil Sternal Retractor, Delacroix-Chevalier) to elevate the chest wall.

Extrapleural technique: mediastinal pleura is separated gently from the endothoracic fascia, meticulously avoiding its opening. The endothoracic fascia is then incised medially and the LIMA and both satellite veins are exposed. The LIMA is dissected from the chest wall using electrocautery on pedicle, containing concomitant veins, adipose tissue, and endothoracic fascia. The arterial branches are ligated with small-size haemoclips, only at the IMA side. The LIMA is mobilized along its entire length. The pedicle is wrapped in gauze soaked in warm papaverine solution. After heparin is administered, the LIMA distal end is cut and secured. All these stages of harvesting are performed from outside the pleural cavity. Before sternal closure, only one drainage tube is placed in anterior mediastinum.

Intrapleural technique: the main difference from the previously described technique is the wide incision, parallel to the sternum, in the mediastinal pleura, performed immediately after Couëtil retractor placement. After this pleurotomy, LIMA is harvested from the pleural cavity. At the end of operation, an additional drainage tube is placed into the left pleura. All patients receive coronary surgery with extracorporeal circulation and aortic cross-clamping, moderate hypothermia (28°C), and myocardial protection with ante- and retrograde cold blood cardioplegia.

Statistical analysis

Statistical analyses were performed using SPSS version 21 (IBM, Armonk, NY, USA). Qualitative variables were expressed as numbers (n), and percentages (%). Continuous quantitative variables with normal distribution with average value and standard deviation, and in the absence of normal distribution with median. Quantitative data were examined by Kolmogorov-Smirnov test for normality of the distribution. We used the Student *t*-test to compare continuously normally distributed data and the Mann-Whitney test in the absence of normal distribution. The comparison of qualitative variables was made using the χ^2 test or the exact Fisher test, when necessary. Differences for which the *p* value was less than 0.05 were considered statistically significant.

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
1. Multivessel coronary artery disease	1. One- or two-vessel coronary artery disease
2. Elective surgical revascularization	2. Combined cardiac surgery procedures
3. Ejection fraction >45%	3. Surgical revascularization without ECC and aortic cross-clamping
4. Harvesting only LITA	4. Chronic kidney disease >stage 2
5. ECC operation with aortic cross-clamping and blood cardioplegia	5. Chronic obstructive pulmonary disease or other lung disease
6. Body mass index <30 kg/m^2	6. Cerebrovascular disease
7. Age <70 years	7. Coronary endarterectomy

RESULTS

Preoperative characteristics

Preoperative characteristics and risk factors are presented in **Table 2**. We found no significant differences between groups.

Intraoperative data

The same surgeons performed both types of operations and all patients were treated according to the same protocol for postoperative analgesia and rehabilitation. The mean number of distal anastomoses was 3.5±1.4 for group 1 and 3.3±0.9 for group two (p=0.942). The mean period of extracorporeal circulation was 88.5±19.4 minutes for Group 1 and 82.6±15.4 minutes for Group 2 (p=0.712). The mean periods of aortic clamping were 61.2±11.5 and 58.3±9.1 minutes, respectively (p=0.897). The differences between these parameters were not significant.

Postoperative data

The registered postoperative data are presented in **Table 3**.

Analysis of the postoperative variables showed that in the group of patients with intact pleura, there was significantly lower rate of atelectasis 5 days postoperatively, as well as large pleural effusions requiring evacuation by day 5 and day 30. Because several patients had both atelectasis and pleural effusions, we compared their absolute number, which was 12 in the group with open pleural cavity and 3 in the group with intact one (7.9% vs. 27.7%), which was found as a statistically significant difference (p=0.04). The values of the other indicators showed advantage for the group with preserved pleural integrity, but the statistical analysis did not confirm significance.

DISCUSSION

In the literature, the conclusions of similar studies confirm our results. We found a significant difference between the study groups in terms of the number of patients who developed atelectasis and pleural effusions in the postoperative period. In our opinion, the logical explanation for this finding is the fact that pleurotomy helps to retain blood in the pleural cavity in the early postoperative period, despite the presence of a tube in it, and increases the patient's discomfort, limits the full range of respiratory mechanics and expectoration. These factors contribute to atelectasis detection, and residual blood probably causes irritation with subsequent imbalance between secretion and resorption of pleura layers. Some authors explain this finding[5] with the pleurotomy itself, which causes changes in the composition of the surfactant leading to deterioration of its properties and subsequent alveolar dysfunction. According to

Table 2. Preoperative characteristics and risk factors

Variables	Group 1 n=38	Group 2 n=44	p
Age, years ± SD	68.3±2.8	69.8±1.2	0.894
Men, n (%)	29 (76.3)	32 (72.7)	0.578
Diabetes, n (%)	12 (31.5)	13 (29.5)	0.908
CKD, n (%)	3 (7.9)	3 (6.8)	0.427
Smoking, n (%)	21 (55.2)	25 (56.8)	0.361
Arterial hypertension, n (%)	38 (100)	43 (97.7)	0.997
BMI, kg/m^2±SD	28.6±3.1	29±2.5	0.156
EF, %±SD	51.2±4.5	49.5±5.3	0.226
Syntax score ±SD	28.4±5.3	27.6±3.2	0.575
EuroScore ±SD	2.8±2.2	3.1±1.5	0.443

average age in years, average body mass index, average ejection fraction, average syntax score, average EuroScore; CKD: chronic kidney disease

Table 3. Postoperative data

Variables	Group 1 n=38	Group 2 n=44	p
Atelectasis			
1st pod, n (%)	8 (21.5)	19 (43.2)	0.065
5th pod, n (%)	3 (7.9)	10 (22.7)	0.015
Pleural effusion			
5th d, n (%)	2 (5.2)	8 (18.2)	0.004
30th d, n (%)	1 (2.6)	4 (9.1)	0.003
Time to extubation, h±SD	6.8±1.4	8.4±1.1	0.689
Drainage bleeding, ml±SD	384.5±103.6	805.7±153.3	0.085
Hospital stay, d±SD	7.8±1.34	8.1±1.11	0.166
Catecholamines, n (%)	12 (31.6)	15 (34.1)	0.892
pO_2, mmHg, mean±SD			
at 1 hour	280±34	263±38	0.594
at 12 hours	161±46	149±44	0.498
at 36 hours	120±32	116±28	0.445
pCO_2, mmHg, mean±SD			
at 1 hour	31±8	33±10	0.856
at 12 hours	38±9	40±8	0.894
at 36 hours	39±6	41±8	0.945
SaO_2%, mean±SD			
at 1 hour	99±0.9	99±0.8	0.981
at 12 hours	99±0.8	99±0.8	0.999
at 36 hours	99±0.8	98±0.7	0.923

pO_2: group average of oxygen partial pressure; pCO_2: carbon dioxide; SaO_2: arterial saturation

most studies, blood loss is reduced in patients with intact pleura.[3,6-8] In our study, we did not find a significant difference. We also did not identify any patient to revise for bleeding or pericardial drainage. Ozkara et al.[9] found a clear advantage in patients with preserved pleural integrity over those with pleurotomy in terms of the frequency of postoperative pleural effusion and atelectasis in the postoperative period. In addition, they found that patients who underwent pleurotomy showed significantly worsened values at the spirometry test (pulmonary function test). We did not perform a spirometry test in this study, although such data would further objectify our conclusions. Ghavidel et al.[10] reported that in addition to pleural effusions and atelectasis, patients with impaired pleural integrity also had a significantly increased duration of postoperative hospital stay. We did not find such a difference in our groups. The comparisons between medians of the studied variables of the blood gas analysis during the first 36 hours also did not show a significant difference, probably due to the selection of low-risk patients and the short period of active monitoring (36 hours).

Limitations

The retrospective nature of this study suggests the inherent risk of bias. In order to reduce it, we have tried to consider mainly objective data, the result of laboratory or instrumental research. Other disadvantages are the small number of patients operated in only one center and the lack of introduction of any objective variables such as data from pulmonary functional tests and others.

CONCLUSIONS

The extrapleural technique for LITA reduces significantly the rate of complications (atelectasis and pleural effusions) in the early postoperative period after myocardial revascularization surgery, but the integrity of the pleura does not seem to interfere with the pulmonary function in the early postoperative hours.

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Экстраплевральное выделение внутренней грудной артерии – влияние на ранние послеоперационные результаты и лёгочную функцию

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Резюме

Введение: Внутренняя грудная артерия (ITA) оказалась лучшим трансплантатом для хирургической реваскуляризации миокарда, особенно в конфигурации левой ITA (LITA) с передней нисходящей ветвью левой коронарной артерии (LAD). Её выделение обычно сопровождается плевротомией с последующей установкой дренажной трубки в плевральную полость так называемым внутриплевральным методом. Экстраплевральная техника выделения LITA также практикуется во многих кардиохирургических центрах, и при этой технике плевра остается интактной.

Цель: Целью нашего исследования было изучить влияние обоих методов выделения LITA на функцию лёгких и частоту послеоперационных осложнений в раннем периоде после операции.

Материалы и методы: Ретроспективно были проанализированы данные 82 оперированных больных, которым была назначена хирургическая реваскуляризация миокарда и которые соответствовали определённым критериям включения и исключения. В зависимости от способа выделения LITA пациенты были разделены на две группы. Параметры лёгких и частоту хирургических осложнений регистрировали в раннем послеоперационном периоде до 30-ого дня.

Результаты: Пациенты обеих групп имели сходные предоперационные характеристики и факторы риска. У пациентов с сохранённой плеврой в раннем послеоперационном периоде наблюдались значительно лучшие результаты изучаемых лёгочных показателей и меньшая частота осложнений.

Заключение: Сохранение целостности плевры во время выделения LITA благотворно влияет на функцию лёгких и снижает частоту осложнений в раннем послеоперационном периоде.

Ключевые слова

аортокоронарное шунтирование, внутренняя грудная артерия, плевральная полость, функция лёгких