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РОССИЙСКОЕ КАРДИОЛОГИЧЕСКОЕ ОБЩЕСТВО

A single-center experience involving the first 50 patients of minimally invasive cardiac surgery of coronary artery bypass grafting: at district level

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Aim. To examine the learning curve and results of the first 50 instances of coronary artery bypass grafting (CABG) that were done at our facility using minimally invasive cardiac surgery (MICS).

Material and methods. A total of 50 patients received CABG using the left anterior thoracotomy technique between January 2021 and November 2022. We examined the MICS CABG patients' operating hours to assess our learning curve. In addition, we reviewed postoperative outcomes and compared them with those of patients who underwent sternotomy.

Results. The median age was 49.5 years (the range was 27-72). Males made up 38 of the group, while females — 12. Ejection fraction (EF) before surgery averaged 40±5%. After exclusion criteria were met, all of these patients underwent CABG by left-sided thoracotomy. The radial artery and saphenous vein were the next alternate conduits, and all patients got left internal mammary artery (LIMA) to left anterior descending (LAD) artery as a conventional transplant. The average incision length was 7.08±0.5 cm. On the pump, only 1 case was completed. Per patient, there were 2.53±0.82 grafts on average. On average, the operation took 130.43±9.78 minutes. The median intensive care unit (ICU) length of stay was 2.82±0.74 days, while the median ventilation time was 5.79±1.80 hours. In our study, there were no conversions and no deaths. After the first 20 cases, we noticed a considerable decrease in operating time, which was our learning curve.

Conclusion. Once the learning curve has been overcome, MICS CABG can be performed for multivessel disease with the same comfort for the operator as for a single- or double-vessel disease. Only during the learning curve, and not subsequently, there were greater operating time for MICS CABG observed as a significant difference from the sternotomy technique. While there was no difference in postoperative adverse events, there were notable advantages of MICS vs sternotomy in the parameters of immediate postoperative time such as ventilation time, mean drainage, postoperative discomfort, length of stay in ICU and hospital.

Keywords: district level, minimally invasive cardiac surgery, coronary artery bypass grafting, learning curve.

Relationships and Activities: none.

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Первый опыт проведения миниинвазивного коронарного шунтирования у 50 пациентов в условиях окружного медицинского центра в Индии

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Цель. Изучить кривую обучения и результаты первых 50 случаев проведения шунтирования по технологии MICS CABG (миниинвазивная кардиохирургия/аортокоронарное шунтирование (АКШ)) в нашем медицинском центре.

Материал и методы. В период с января 2021г по ноябрь 2022г в общей сложности 50 пациентам было проведено АКШ с использованием передней левосторонней торакотомии. Мы изучили среднюю длительность операций, чтобы оценить кривую обучения. Кроме того, были оценены послеоперационные исходы и затем сопоставлены с таковыми у пациентов, перенесших стернотомию.

Результаты. Средний возраст пациентов составил 49,5 лет (диапазон — 27-72); мужчин было 38, женщин — 12. Фракция выброса до операции составляла в среднем 40±5%. Всем пациентам было выполнено АКШ посредством левосторонней торакотомии.

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В качестве трансплантата левой передней нисходящей артерии (ЛПНА) использовалась левая внутренняя грудная артерия (ЛВГА) в 100% случаев. В ряде случаев также применялись лучевая артерия и большая подкожная вена. Средняя длина разреза составила 7,08±0,5 см. Искусственное кровообращение было использовано только у 1 пациента. В среднем операция занимала 130,43±9,78 минут. Средняя продолжительность пребывания в отделении интенсивной терапии (ОИТ) составила 2,82±0,74 дня, а медиана длительности механической вентиляции легких — 5,79±1,80 часа. Случаев конверсий и смертей не было зарегистрировано. После первых 20 случаев мы заметили значительное сокращение времени операции, что и служило нашей кривой обучения.

Заключение. При преодолении кривой обучения, АКШ по технологии MICS при многососудистом поражении может быть выполнена с тем же комфортом для хирурга, что и при поражении одного или двух сосудистых бассейнов. Большая продолжительность операции наблюдалась только при обучении, что является существенным отличием от стернотомии. Хотя отличий в частоте развития послеоперационных нежелательных явлений не наблюдалось, были заметны преимущества MICS перед стернотомией в рамках ближайшего послеоперационного периода: меньшие длительность механической вентиляции легких, средний объем отделяемого по дренажу, послеоперационный болевой синдром, продолжительность пребывания в отделении интенсивной терапии, общая длительность госпитализации.

Ключевые слова: уровень окружного стационара, малоинвазивная кардиохирургия, аортокоронарное шунтирование, кривая обучения.

Отношения и деятельность: нет.

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ABG — arterial blood gas, AKI — acute kidney injury, CABG — coronary artery bypass graft, CKD — chronic kidney disease, COPD — chronic obstructive pulmonary disease, CPB — cardiopulmonary bypass, CT — computed tomography, DVD — double-vessel disease, ECG — electrocardiography, EF — ejection fraction, FEV1/ FVC — forced expiratory volume in first second/forced vital capacity, GSV — great saphenous vein, HCR — hybrid coronary revascularization, IABP — intra-aortic balloon pump, ICD — intercostal drainage, ICS — intercostal space, ICU — intensive care unit, IMA — internal mammary artery, IV — intravenous, LAD — left anterior descending, LIMA — left internal mammary artery, MI — myocardial infarction, MICS — minimal invasive cardiac surgery, OM — obtuse marginal, OR — operating room, PFT — pulmonary function test, PTCA — percutaneous transluminal coronary angioplasty, PVD — peripheral vascular disease, SVD — single-vessel disease, TEE — transesophageal echocardiogram, TTFM — transit time flow measurement, TVD — triple vessel disease.

Key messages

What is already known about the subject?

- Over the past ten years, minimally invasive heart surgery has developed rapidly.
- Equipment has been improved for coronary, valvular and intracardiac repair operations.

What might this study add?

- Even a multivessel bypass can be successfully completed utilising the MICS technique after a brief learning curve.
- Compared to sternotomy, the minimally invasive cardiac surgery of artery bypass grafting appears to be more advantageous in terms of quick recovery and hospital stay, with no major difference in surgical times or postoperative side events.

Ключевые моменты

Что известно о предмете исследования?

- За последние десять лет быстро развивалась малоинвазивная кардиохирургия.
- Было усовершенствовано оборудование для операций по протезированию коронарных артерий и клапанов сердца.

Что добавляют результаты исследования?

- После короткого обучения технология MICS позволяет выполнить шунтирование при поражении нескольких сосудистых бассейнов.
- По сравнению со стернотомией, шунтирование по технологии MICS оказывается целесообразно с точки зрения более быстрого восстановления и меньшего периода госпитализации, без существенной разницы в общей длительности вмешательства или послеоперационных побочных явлениях.

Background

The benchmark in contemporary cardiac surgery is minimally invasive (MICS) [1, 2]. The widespread understanding of MICS among the population has grown significantly and is now preferred wherever possible. The development of MICS, robotic telemanipulation, and transcatheter procedures involves surgeons on a continuous basis. Recent research has demonstrated the advantages of MICS multivessel coronary artery bypass grafting (CABG) performed by a left anterior thoracotomy and their non-inferiority to sternotomy technique [3]. In this work, we have described our progression from left internal mammary artery (LIMA) through left anterior descending (LAD) grafting to multivessel CABG by left anterior thoracotomy, all of which had satisfactory outcomes.

Material and methods

All patients receiving MICS CABG at our facility between January 2021 and November 2022 were included in this retrospective, observational, non-randomized analysis. Over the above indicated time period, each of these patients was operated on by one surgeon. Despite the fact that the study's primary goal was to document our experiences with MICS,

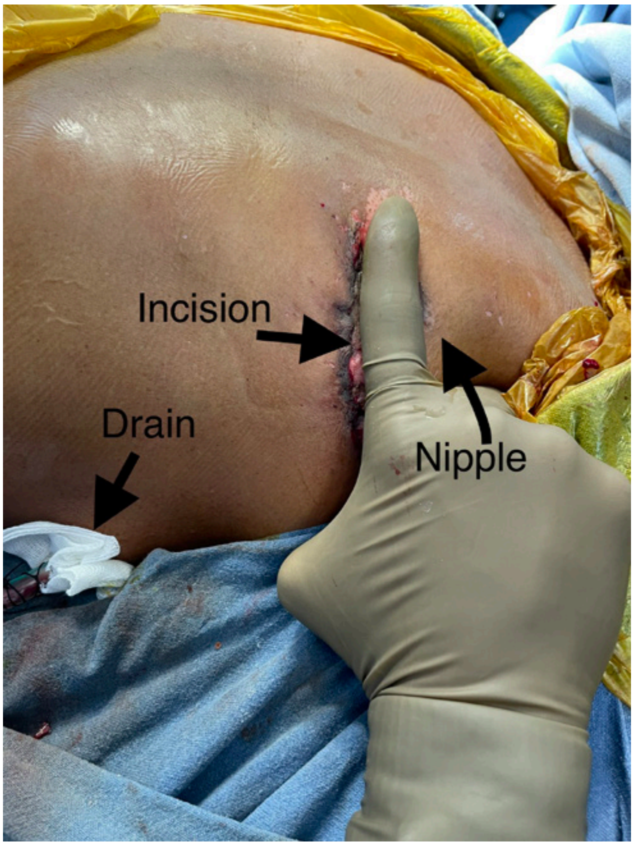

Figure 1 Incision of MICS CABG.

we also conducted an unpaired comparison with patients who underwent CABG through a median sternotomy over the same time frame. Fifty (14.29%) of the coronary revascularizations carried out throughout the research period used a left anterior thoracotomy technique. We have examined our institute's learning curve and operational durations. The study's operating time was the period from the moment of skin incision to the time of skin closure (skin to skin). The first 20 study instances that served as a learning curve and subsequent study instances were compared by time frame. For this research, data for single, double, and triple grafts were examined independently, and the operating time was also contrasted with that of sternotomy. Analysis of the operating time and early postoperative outcomes for the MICS CABG patients, including time spent ventilating, time spent scoring pain, mean total drains, total count of blood transfusions, day spent getting out of bed, and length of stay in the intensive care unit (ICU) and hospital were the study's primary endpoints. Adverse postoperative outcomes include acute kidney injury (AKI), arrhythmias, stroke, recurrent myocardial infarction (MI), wound infections, readmission to the hospital, and mortality were the study's secondary endpoints. To further comprehend the advantages of the MICS procedure, these parameters were compared with those treated using sternotomy.

Inclusion and exclusion criteria

The trial comprised all patients who were willing to undergo MICS CABG and had target coronary arteries, which, according to coronary angiography, could be grafted by left thoracotomy. A coronary angiography, an electrocardiogram (ECG), a chest radiograph, a 2D echocardiogram, and supporting blood tests were all part of the preoperative workup. Since the MICS technique was still under development at our institution, patients who were considered unsuitable for it or who refused to consent to it underwent surgery using the standard median sternotomy technique. Since full revascularization was not attainable in a small cohort of patients using a MICS technique, we advised the patients to have a hybrid coronary revascularization (HCR). Exclusion criteria for the study included patients with associated valvular pathology, congenital abnormality, diffuse coronary artery disease with poor distal runoff, ejection fraction (EF) <24%, history of previous cardiac surgery, acute/recent MI within the last 7 days, peripheral vascular disease (PVD), smokers, history of tuberculosis or interstitial lung diseases, spine deformities like scoliosis or kyphosis, and recent history of stroke. For MICS, relative contraindications including obesity and big breasts in females were permitted. We had a higher bar for eliminating these individuals due to the high frequency of chronic kidney disease (CKD) in our patient population. If the serum creatinine was <1.8 mg/dL and did not increase over the course of three consecutive preoperative days, these individuals were included in the MICS study. Smokers were only permitted after quitting for at least 4 weeks prior to surgery. Pulmonary function testing (PFT) and a peripheral vascular (arterial and venous) Doppler studies were performed on patients who had smoked in the past. A $PaCO_2$ >50 mmHg and PaO_2 <65 mmHg on room air, as well as a ratio of the forced expiratory volume in the first 1 s to the forced vital capacity (FEV1/ FVC) <0.75 were not recognised for one lung ventilation.

Aspects of procedure

Patients who met the aforementioned exclusion criteria were accepted for MICS CABG. Preoperative arterial blood gas (ABG) analysis was used to confirm the requisite values, i.e., $PaCO_2$ <50 mmHg and PaO_2 >65 mmHg on room air, as determined by the anesthesiologist when determining if the patient was suitable for one lung ventilation [4]. Patients who failed to achieve the aforementioned requirements on an ABG were removed from the trial. The placement of the patient was a crucial step in preventing subsequent visual-related procedural issues. The usual posture was with both upper limbs in adduction and the left chest elevated by 30 degrees. The midline and intercostal spaces (ICS) (particularly the third through fifth) were delineated with a sterile marker pen after the patient was draped (Figure 1). Based on the level of the cardiac apex on the chest radiograph, the fifth ICS was often used to enter the thorax. Males had the incision about fingerbreadth below the left nipple, while females had it a half-inch below the left sub-mammary crease. Whenever there was a problem with either accessibility or visualisation, an ICS modification was taken into consideration. At our facility, Fehling MICS tools, such as the chest spreader and internal mammary artery (IMA) arc retractor, were utilised. Early on in the experiment, LIMA was harvested using monopolar cautery. The initial intercostal branch was divided and trimmed. Due to bleeding in this situation, cautious trimming and sufficient hemostasis were required. The left radial artery (78%) and the great saphenous vein (GSV) (8%) were employed as auxiliary conduits. The second channel of preference was radial artery. As a result, it was not necessary to build a proximal aortic anastomosis and LIMA-radial Y anastomosis was possible. Three different myocardial stabilisers were used: the traditional Octopus® Evolution AS (TS2500, Medtronic Inc., USA). The visibility and positioning of the target vessel affected the choice of stabilising tools. When it was utilised, the traditional Octopus was attached to either the rib spreader or the manubrium hook of the arc retractor. Prior descending artery was grafted first, then the diagonal, ramus, obtuse marginal (OM), and LAD. In successive grafts employing the LIMA, the diagonal was the first to be grafted, and end to side LAD anastomosis was done next. With 7-0 polypropylene sutures and an 8-mm needle, all of the distal anastomoses were completed. Using a "0" silk suture, pericardial stay sutures were made along the pericardial borders and fastened to the drape sheets to ensure the heart was positioned correctly. The Langenbeck retractor's handle was used to move the heart, and sponges were positioned at the back to hold it in place. More frequently than the OM artery, we had trouble exposing the PDA. After setting the heart in place, we waited a little while to ensure cardiac stability before starting the grafting process. Octopus was inserted for LAD and diagonal anastomoses by a stab incision made along the anterior axillary line, two ICS below the thoracotomy incision. For the rest of the grafts, we used traditional Octopus to continue grafting after lifting the apex (Figure 2). We employed the standard Octopus when the available area and visualisation were deemed sufficient. Our standard procedure was off-pump CABG. Cardiopulmonary bypass (CPB) was only used during surgery on one patient out of 50 owing to intraoperative hemodynamic instability. In all of our patients, the right groin was wrapped and kept ready. An open incision down that exposed the femoral artery and vein was followed by cannulation. On that instance were handled using the beating heart on-pump approach. After decannulation, the femoral artery and vein were reconnected in two layers using a 6-0 polypropylene suture. The next day, those patients were taken for percutaneous transluminal coronary angioplasty (PTCA) with a stent to the target artery in cases where the targeted grafts could not be performed by left-sided thoracotomy. We conducted PTCA in the cardiac catheterization lab since we lacked a hybrid operating room (OR). A pericostal number 5 polyester suture was used to approximate the rib gap during thoracotomy closure. Layers of number 1 Vicryl intermittent sutures were used to seal the muscles of the chest wall. Our protocol consisted of one ventricular epicardial pacing wire and one chest drainage catheter. The same port that was used to inject the Octopus stabilising device was also used to introduce the chest drain.

Management and follow-up after surgery

Intravenous (IV) infusion of diltiazem was begun at 10 mg/h in the OR and continued for the following 24 hours in patients who had radial artery grafts. Eventually, it was switched to oral diltiazem dose of 30 mg three times/day. In our hospital, the standard pain management procedure was to extubate the patient while continuing an IV fentanyl infusion of 0.75 to 1 mcg/h. After being extubated, patients received 1 g of Intravenous paracetamol every 6 hours for the following 24 hours before switching to 650 mg of oral paracetamol every 6 hours. At this time, the Wong-Baker Facial pain rating scale was used to evaluate the severity of the pain, with values ranging from 0 (no pain) to 10 (hurts worst). During the first three days after surgery, we tracked pain score. If the total drain was <100 ml over 24 hours, the intercostal drainage (ICD) tube was withdrawn. Aspirin (150 mg) and clopidogrel (75 mg) were the dual antiplatelet drugs we were given upon discharge, along with a lipid-lowering prescription. For 12 months following surgery, patients who got radial artery as a conduit were instructed to take 90 mg/day of oral diltiazem. Outpatient follow-ups of patients were evaluated. A 2D echocardiogram, an ECG, and chest radiography were all part of the follow-up. A follow-up visit was required one week after release, three months later, and then every six months thereafter. During a 12-month period, a chest radiography, 2D echocardiography, an ECG, and a computed tomography (CT) coronary angiography were all recommended.

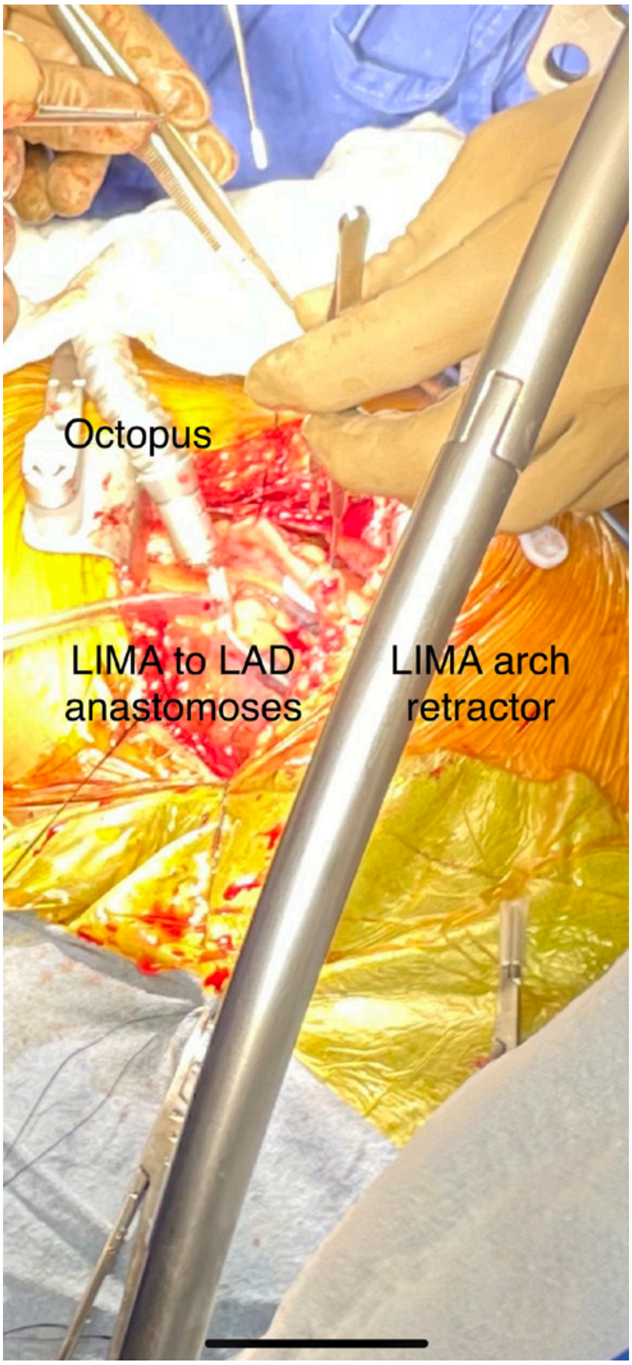

Figure 2 Image showing Octopus and LIMA arch retractor.

Statistic evaluation

Using IBM SPSS 2.0 statistics for Windows, the data was tabulated and examined. Co-morbidities and complications were represented as percentages and frequencies for various parameters. Age, echocardiogram, operating time, and other variables were presented as mean ± standard deviation.

This study was approved by the institutional ethical committee. All procedures performed in studies involving

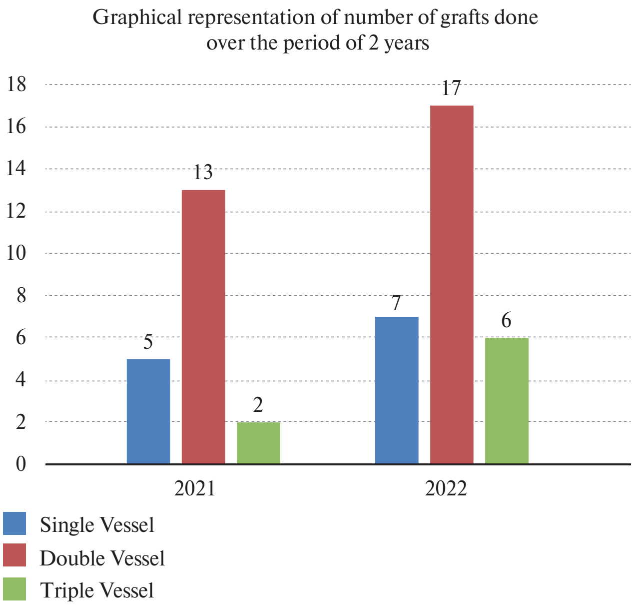

Figure 3 Characteristics of the patient: prior surgery.

Table 1

Characteristics of the patient prior surgery

Pre-operative patient characteristics (n=50)	
Mean age (years)	49.5 (range 27-72)
Male/female	38 (76%)/12 (24%)
Hypertension	38 (76%)
Diabetes mellitus	28 (56%)
Canadian Cardiovascular Society (CCS) grading	
Grade I	0
Grade II	4
Grade III	36
Grade IV	10
Smokers	28 (46%)
Chronic kidney disease	4 (8%)
Thyroid disorder	14 (28%)
Mean pre-op ejection fraction (in %)	40±5
COPD	14 (28%)
Cardiogenic shock (recovered)	8 (16%)
Prior PTCA	18 (36%)
Previous MI	12 (24%)
Unstable angina	9 (18%)
LMCA disease	15 (30%)
SVD	12 (24%)
DVD	30 (60%)
TVD	8 (16%)

Note: COPD — chronic obstructive pulmonary disease, PTCA — percutaneous transluminal coronary angioplasty, LMCA — left main coronary artery, SVD — single vessel disease, DVD — double vessel disease, TVD — triple vessel disease, MI — myocardial infarction.

human participants were in accordance with the ethical standards of institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Parul Institute of Medical Sciences and Research Ethical Committee approved the study (Number: 580 Date: 15.11.2022). Written informed consent was obtained from patients or their legal guardians for participation in the study.

Results

Patient features before surgery

A total of 375 cardiac operations, including 303 (80.8%) coronary revascularizations and 72 (19.2%) non-coronary procedures, were carried out at our facility between January 2021 and November 2022. Fifty (16.51%) of the total number of coronary revascularizations were performed using the left anterior thoracotomy. For 2021 and 2022, respectively, MICS coronary revascularizations represented 40% (n=20) and 60% (n=30) of all coronary revascu-larizations. In the first year, there were 10% (n=5), 26% (n=13), and 4% (n=2) single, double, and triple grafts, compared to 14% (n=7), 34% (n=17), and 12% (n=6) in the second year, respectively (Figure 3). The MICS patients ranged in age from 27 to 72 years, with a mean age of 49.5. The research included 38 males (76%) and 12 females (24%), with men making up the majority of the population. In addition, 38 (76%) and 28 (56%) patients had diabetes mellitus and arterial hypertension, respectively. The average EF before surgery was 40±5%. Just four patients were in grade II during the preoperative period, whereas the majority of patients were in grades III (72%) and IV (20%) according to the Canadian Cardiovascular Society (CCS). The other comorbidities included CKD in 4 (8%), chronic obstructive pulmonary disease (COPD) in 14 (28%), and hypothyroidism in 14 (28%) patients, which received oral levothyroxine and were confirmed to be euthyroid prior to surgery. Twelve (24%) patients had previous MI, 9 (18%) — unstable angina, and 18 (36%) — prior PTCA. Fifteen (30%) patients had left main coronary artery (LMCA) disease, while 12 (24%) of them had single vessel disease (SVD), 30 (60%) — double vessel disease (DVD), and 8 (16%) — triple vessel disease (TVD) (Table 1). Eight patients had cardiogenic shock. Medical care was provided for them, and 1 patient needed an intra-aortic balloon pump (IABP) therapy.

Operative specifics

Only 1 patient required CPB support during surgery, while 49 patients received off-pump operation. The incision length averaged 7.08±0.5 cm. There were 2.53±0.82 grafts on average per patient. Thirteen patients had one graft, 28 — two grafts, and nine patients — three grafts. All 50 patients had LAD grafts, and 12 of those patients also had grafts to the diagonal, 12 of which were LIMA to diagonal and LAD sequences. A ramus graft was given to 15, an OM graft to 24, and a PDA graft to 38 patients. The ratio of intended grafts to the performed grafts was 153/125. The average operating time of all 50 cases was 130.43±9.78 min. The mean operating time in minutes based on

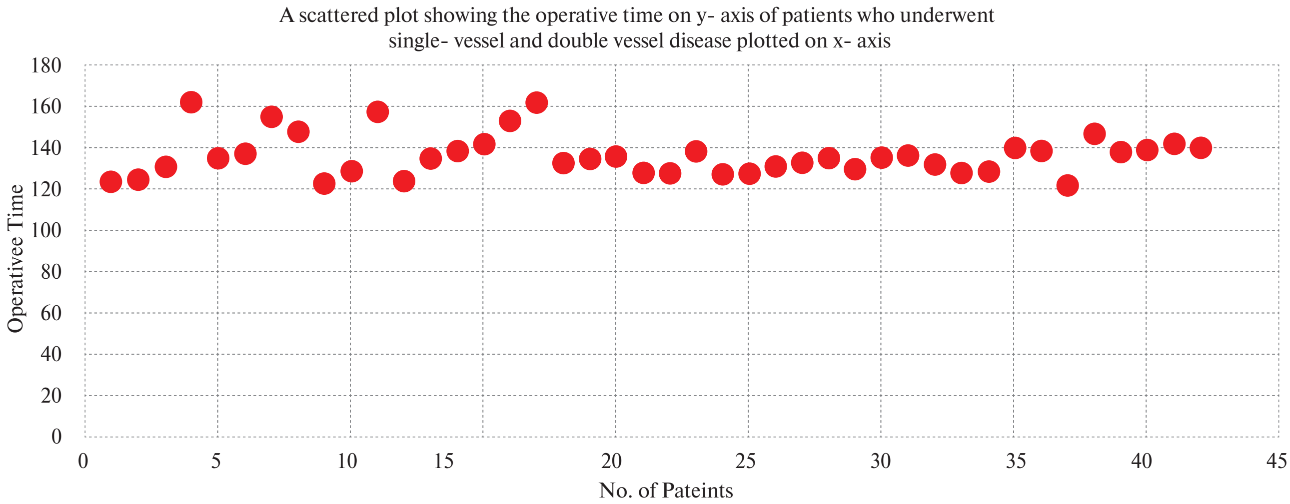

Figure 4 Graph showing operative time of single-vessel and double-vessel disease patients.

Table 2

Patient characteristics intraoperative

Intraoperative patient characteristics (n=50)	
On pump	1 (2%)
Off pump	49 (98%)
Average size of incision (cm)	7.08±0.5
Conduits	
LIMA	50 (100%)
Radial	34 (78%)
Saphenous vein	4 (8%)
Grafts	
LAD	50 (100%)
Diagonal	12 (24%)
Ramus	15 (30%)
OM	24 (48%)
PDAя	38 (76%)
Total grafts (average)	2.53±0.82
Ratio of intended grafts to performed grafts	(153/125)
Number of grafts	
Single graft	13
Two grafts	28
Three grafts	9
LIMA used as sequence to diagonal and LAD	0 (0%)
Conversion to sternotomy	1 (2%)
Re-explorations	1 (2%)
Graft revision	0 (0%)
Procedure time in min (mean) (n=50)	130.43±9.78
Mean operative time for single grafts (min) (n=12)	120.8±36.55
Mean operative time for two grafts (min) (n=30)	130.14±22.58
Mean operative time for three grafts (min) (n=8)	140.35±9.67

Note: LIMA — left internal mammary artery, LAD — left anterior descending, OM — obtuse marginal, PDA — posterior descending artery.

Table 3

Postoperative patient features

Postoperative patient characteristics (n=50)	
Mean duration of ventilation (hours)	5.79±1.80
Total drainage in ml (mean)	202±0.49
Mean no. of blood transfusions	2.25±0.75
Pain score: Wong–Baker Faces pain rating (0 to 10) (mean)	
POD 1	4.18±0.79
POD 2	3.43±0.38
POD 3	2.12±0.45
Mean day of mobilization out of bed	1.43±0.26
Acute kidney injury	0 (0%)
Arrhythmias	0 (0%)
Stroke	0 (0%)
ICU stay (mean no. of days)	2.82±0.74
Hospital stay (mean no. of days)	4.09±0.76
Post-op EF (in %)	41.42±4.38
Perioperative MI	0
Readmission into hospital within 30 days	0 (0%)
Deaths	0
Wound infections	1 (2%)

Note: ICU — intensive care unit, EF — ejection fraction, MI — myocardial infarction, POD — postoperative day.

the number grafts were 114.8±37.55, 113.14±21.58 and 145.21±14.6 for 1, 2 and 3 graft cases, respectively (Table 2). We analyzed our results in a similar way to the study by Une D, et al. [5]. We plotted scatter chart of the operating time for the single and double graft group in a sequential order from the beginning of the program (Figure 4). This graph clearly shows a dip after the 18th case.

Postoperative details

The mean ventilation time was 5.79±1.80 hours. Wong-Baker Faces pain rating (0 to 10) (mean) was measured (Table 3). The value for postoperative day 1, 2 and 3 are 4.18±0.79, 3.43±0.38 and 2.12±0.45 respectively. There was no AKI, arrhythmias and stroke. Average length of stay in ICU was 2.82±0.74 days. Mean postoperative ejection fraction was 41.42±4.38%. There was 1 case of wound infection out of the 50 MICS

Table 4

Parameter comparisons between the MICS CABG and sternotomy groups at baseline, during surgery, and during recovery

Parameter	MICS CABG (n=50)	Sternotomy (n=300)
Mean age (years)	49.5 (range 27-72)	63.68±8.68 (range 32-89)
Males/females	38 (76%)/12 (24%)	198 (66%)/102 (34%)
Hypertension	38 (76%)	232 (77%)
Diabetes mellitus	28 (56%)	246 (82%)
CKD	4 (8%)	16 (5.33%)
Thyroid disorder	14 (28%)	56 (18.66%)
COPD	14 (28%)	102 (34%)
Cardiogenic shock (recovered)	8 (16%)	24 (8%)
Preoperative EF (mean)	40±5	45.13±9.56
Average number of grafts	2.53±0.82	2.62±0.73
Off pump/on pump	49 (98%)/1 (2%)	262 (87.33%)/38 (12.67%)
Intraoperative IABP	1 (2%)	24 (8%)
Duration of ventilation (mean hours)	5.79±1.80	7.34±2.25
ICU stay (mean no. of days)	2.82±0.74	3.28±1.02
In-hospital stay (mean no. of days)	4.09±0.76	6.78±1.43
Day out of bed (mean day)	1.43±0.26	2.52±1.31
Total drainage in ml (mean)	202±0.49	223.76±34.15
Transfusions (mean units)	2.25±0.75	3.19±0.77
Re-explorations	1 (2%)	15 (5%)
Graft revisions	0 (0%)	10 (3.33%)
AKI	0 (0%)	5 (1.66%)
Arrhythmias	0 (0%)	32 (10.66%)
Stroke	0 (0%)	2 (0.66%)
Postoperative EF (mean)	41.42 ± 4.38	46.86±8.12
Death	0	4 (1.33%)
Perioperative MI	0	8 (2.66%)
Deep sternal wound infections	1	9 (3%)
	MICS CABG (n=50)	Sternotomy (n=300)
One graft	13	30
Two grafts	28	80
Three grafts	9	190
One grafts duration	120.8±36.55	98.45±12.77
Two grafts duration	130.14±22.58	106.56±23.2
Three grafts duration	140.35±9.67	125.88±19.43

Note: AKI — acute kidney damage, CABG — coronary artery bypass graft, CKD — chronic renal disease, COPD — chronic obstructive pulmonary disease, IABP — intra-aortic balloon pump, ICU — intensive care unit, MI — myocardial infarction, MICS — minimal invasive cardiac surgery.

operations done. Mean total drain output was 202 ml. Mean number of blood transfusions required was 2.25.

Sternotomy patient information

We collected data of patients who underwent coronary revascularization via midline sternotomy route during the same time duration. A total of 300 patients underwent coronary revascularization via the sternotomy approach, of which isolated elective CABG was done in all 300 patients. The mean age of all patients was 63.68±8.68 (range 32-89), including 198 males and 102 females. In addition, 77, 82, 5.33, 18.66, and 34% of patients had arterial hypertension, diabetes mellitus, CKD, thyroid disorder and COPD, respectively. Mean preoperative EF was 45.13±9.56. Average number of grafts used per case was 2.62±0.73. There were 262 and 38 cases receiving off- and on-pump surgery. Mean ventilation was 7.34 hours. Mean length of stay in ICU was 3.28 days. Fifteen cases required reexplorations, graft revisions were required in 10 cases. AKI and arrhythmias were found in 5 and 32 cases, respectively. Mean postoperative ejection fraction was 46.86. There were 4 deaths. Deep sternal wound infections were found in 9 cases. Single, double, and triple grafts were used in 30, 80 and 190 patients, respectively. The mean operation duration was 98.45±12.77, 106.56±23.2 and 125.88±19.43 in single, double and triple graft procedures, respectively. Comparisons of all the postoperative parameters in MICS and sternotomy cases are shown in Table 4.

Discussion

Over the past ten years, minimally invasive heart surgery has developed rapidly. Equipment has been improved for coronary as well as valvular and intracardiac vascular repair operations. The learning curve for the MICS approach seems to be its only drawback [6, 7]. It is undoubtedly a laborious and time-consuming process because the surgeon must complete each step through a tiny aperture with poor visibility, and perhaps most significantly there is no help at hand. Throughout their path to a MICS CABG procedure, everyone starts with a single LIMA to LAD graft. It is widely known that while the first few cases may be difficult and time-consuming, once the learning curve is reached, the operative times dramatically decrease [5, 8]. After the 20th case, which served as our learning curve in our study, we discovered a considerable decrease in the operative timeframes. Following the learning curve, we found no discernible difference between the MICS and sternotomy patient groups in terms of the amount of time required for surgery, whether it be for a single, double, or multiple vessels. During the surgery, ventricular arrhythmias may cause hemodynamic instability. For all MICS instances, we place external defibrillation pads over the patient's back before surgery because it is very difficult to shock a patient with handheld paddles (paediatric paddles may be used if necessary) through a thoracotomy. Maintaining the right groin wrapped and prepared to access femoral vasculature for CPB cannulation became usual for us. If CPB is necessary, it has been demonstrated that an on-pump beating heart approach was not worse in this situation than a full bypass with cardioplegic arrest [8]. For cannulation, our procedure was to cut open the femoral veins. Adjusting the intercostal gap after the incision was made helped with visibility, particularly when grafting the targets for the inferior territory. It could be necessary to move one space above in order to cut the LIMA's first intercostal branch. To avoid breaking the ribs, we tried to spread the retractor as little as possible. Any target vessel can be visualised with the application of proper stay sutures and the insertion of sponges to raise the heart, but excessive manoeuvring can lead to cardiac instability and should be avoided. Even with MICS-CABG, the long-term advantages of LIMA versus LAD have already been clearly demonstrated [9]. LIMA must be harvested carefully because it is an essential conduit [10]. We discovered that LIMA could be collected safely and easily using a harmonic scalpel, as described by Nambala S [11]. For the first few cases, the harvesting period was longer. Bilateral IMA has not yet been used on any of our patients. Our second choice for a conduit was the radial artery, then the GSV. Prior to any distal anastomosis, the LIMA-radial Y composite anastomosis was performed to prevent contacting the aorta [12]. None of the patients had an endarterectomy. Patients of any age or sex can greatly benefit from MICS's advantages, particularly reducing the possibility of a sternal wound infection. The advantages of MICS over sternotomy in elderly patients older than 70 have also been investigated [13]. The MICS group's postoperative discomfort was discovered to be less than that of the sternotomy patients. Another advantage of MICS is early mobilisation since the sternum is kept in good condition [14]. The ICU and hospital stay were found to be shorter in the MICS group, but not significantly different from the sternotomy group. The OR can embrace the usage of TTFM for the graft flow assessment. If the graft flow does not meet the specified values of TTFM, graft revision may be performed right away rather than waiting until after surgery [6]. In all of our grafts, whether made via a sternotomy or a MICS technique, we now quantify the flow thanks to the new introduction of this flowmetry. Transesophageal echocardiography (TEE), which is performed on a table, is another important technology that provides quick results for anomalies in localised wall motion. All of our patients had TEE in the OR following their procedures [4, 15]. The adoption of HCR was more common in the early stages of our MICS program, when we attempted multivessel grafting less frequently. It would be acceptable to say that CABG can now be carried out using the left thoracotomy method, whether the disease pattern affects a single vessel or several vessels. For successful outcomes, patients must be carefully chosen and assessed before the procedure.

Conclusion

Comparing MICS CABG surgeries to sternotomy procedures, the percentage still remains low. Even a multivessel bypass can be successfully completed utilising the MICS technique after a brief learning curve. Compared to sternotomy, MICS CABG appears to be more advantageous in terms of quick recovery and hospital stay, with no difference in surgical times or postoperative side events. Limitation of support and paramedical staff and a single surgeon centre can increase the learning curve of MICS, while proper technique, proper patient selection and good surgical skill can establish a MICS program even in a subdistrict division level. Long-term follow-up is not yet mentioned in the study as it only lasts for two years.

Relationships and Activities: none.

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