ORIGINAL ARTICLE

Minimally invasive coronary artery bypass (MICS CABG) in Bosnia and Herzegovina: a single centre, single surgeon cohort experience

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ABSTRACT

Aim This is the first research in Bosnia and Herzegovina presenting minimally invasive coronary artery bypass grafting surgery (MICS CABG) experience, advantages, and outcomes as compared to conventional surgery (OPEN CABG).

Methods This retrospective cross-sectional study was conducted between January 2019 and November 2022 and included patients with indication for surgical revascularization.

Results Among 237 patients, males predominated, 182 (76.7%), with a mean body mass index (BMI) of 28.4±3.9, median The Society of Thoracic Surgery Risk (STS) score of 1.55 (0.8, 4.0), short term STS score of 11.2 (6.8, 23.7), mean age of 64.8±8.7 (ranging 41-83) years, 122 (51.4%) underwent OPEN CABG and 115 (48.6%) MICS CABG. MICS CABG took less time ($p<0.001$; OPEN 3.5±0.8h; MICS 2.8±0.8h) and needed less mechanical ventilation ($p<0.001$, OPEN 17.3±11.9h; MICS 13.0±12.5h) than OPEN CABG. Even though there was no difference in hospitalization length between groups (OPEN (7.5±3.2), MICS (7.1±4.0)), patients receiving MICS (2.9±1.5) spent less time in the ICU ($p=0.0013$) than OPEN CABG (3.6±2.8). OPEN CABG used also more blood derivatives, red blood cells (OPEN 292 vs MICS 55), plasma (OPEN 270 vs MICS 86) and platelets (OPEN 71 vs MICS 28).

Conclusion Patients undergoing MICS CABG in Bosnia and Herzegovina had less mechanical ventilation hours and less ICU duration compared to OPEN CABG even though the hospitalization duration was very similar. MICS CABG takes less time to be conducted, has fewer CPRs postoperatively, uses less blood derivatives including red blood cells, plasma and platelets.

Key words: cardiovascular diseases, cardiac surgical procedures, coronary artery disease-

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INTRODUCTION

Because a large number of potentially fatal complications of arterial thrombosis develop throughout life before appearing as an acute ischemic event (1), a thorough understanding of the pathogenesis of this illness is critical in determining the best mode of prophylaxis and treatment. Ischemic heart illness occurs as a result of an insufficient blood supply to the myocardium (2). The phrase acute coronary syndrome refers to any clinical symptoms associated with acute coronary ischemia, including unstable angina (UA), myocardial infarction without ST elevation (NSTEMI), and myocardial infarction with ST elevation (STEMI) (3). It is necessary to revascularize (4).

When primary percutaneous intervention (PCI) is not possible, fibrinolytic therapy and PCI offer an advantage in the treatment of patients with single vessel illness (4). The PCI would have the benefit in single vessel disease to return to daily activities, but CABG (5) would have the advantage in complicated anatomy, multivessel disease, notably tortuous blood vessels, and diabetic patients (6). Minimally invasive coronary artery bypass grafting surgery (MICS CABG) is the routine, and a significant increase in patient awareness was noticed, and it is now favoured wherever possible (7). Surgeons are continually participating in the process of improving MICS CABG, robotic telemanipulations, and transcatheter interventional procedures (8). There are current studies that show the advantages of MICS CABG done by left anterior thoracotomy and its non-inferiority to the open conventional sternotomy method (OPEN CABG) (9).

The aim of this study was to demonstrate MICS CABG advantages in Bosnia and Herzegovina (B&H), and outcomes as compared to traditional OPEN CABG, according to our experience that began with left internal mammary artery (LIMA) to left anterior descending (LAD) grafting and progressed to multivessel CABG. This is the first research of this kind in B&H.

METHODS

Patients and study design

This retrospective cross-sectional study was conducted in the period between January 2019 and November 2022 at the Clinic of Cardiovascular Surgery of the Clinical Centre of the University of Sarajevo in B&H.

The study included 250 patients admitted at the Clinic of Cardiovascular Surgery at the Clinical Centre of the University of Sarajevo in B&H for coronary artery bypass grafting. Patients who refused elective surgery before coming to the operating theatre were not included in the study, nor were the patients converted from one method to another during the operation. The patients were divided in two groups: those who underwent conventional open heart surgery (OPEN CABG), and those who underwent minimally invasive coronary artery bypass grafting surgery (MICS CABG). After the separation of the patients into groups: OPEN CABG vs MICS CABG, postoperative factors such as procedure duration, mechanical ventilation duration, intensive care unit (ICU) and hospitalization duration, as well as postoperative drainage, usage of blood derivatives and the need of CPR were studied.

All patients who participated in the study were told about their participation, study aims, all information acquired, its purpose, potential results, confidentiality of study data, and a complete informed consent form that each patient was required to fill out.

The study was approved and validated in advance by the Ethical Committee of the Clinical Centre, University of Sarajevo. In the study settings, all Helsinki declaration amendments were followed.

Methods

Each patient had a detailed anamnesis taken before the procedure where data regarding his heart condition, medication allergies, coronary artery disease (CAD) symptoms, previous medical conditions, comorbidities, electrocardiogram (ECG), echocardiography, coronary angiography, 2013 The Society of Thoracic Surgery Risk Score (STS score) (10), and 2018 updated The Society of Thoracic Surgery short term risk (STS Short-Term Risk) (11), which calculated the 30-day patients risk of mortality and morbidities including age, gender, race, weight, height, haematocrit, white blood count, platelet count, last creatinine level, previous comorbidities and therapies, family history, severity of particular blood vessel stenosis, use of drugs, tobacco and alcohol, and immediate preoperative findings were taken.

During and after the surgical procedure, various data regarding the hospitalization duration, procedure duration, mechanical ventilation duration, inotropic and drug support, wound healing, wound drainage, neurological and kidney function, administered cardiopulmonary resuscitation (CPR) and survival were taken and analysed in the study.

Surgical procedure. Open-heart coronary artery bypass grafting (OPEN CABG) surgical procedure was applied that involves the utilization of a median sternotomy incision to access the heart, followed by the use of grafts to bypass occluded or stenotic arteries. The surgeon may use either on-pump or off-pump techniques during the procedure (12).

Minimally invasive coronary artery bypass grafting (MICS CABG) was applied involving the use of small incisions such as anterolateral mini-thoracotomy, rather than a median sternotomy. With minimally invasive CABG, the surgeon uses specialized instruments to access the heart and perform the grafting procedure (12).

Statistical analysis

Normally distributed data were presented as frequencies, percentage and by mean ±standard deviation (SD), while not normally distributed by median (25^{th}, 75^{th} percentile). Descriptive statistics were presented during the 3-year timeline among OPEN CABG and MICS CABG. For parametric data, the independent sample t test was used, and for nonparametric data, the Mann Whitney U test was used. The statistical significance level was set at $p<0.05$.

RESULTS

After excluding 13 patients due to exclusion criteria, the final sample consisted of 237 patients. Males predominated, 182 (76.7%). Mean Body Mass Index (BMI) score of 28.4±3.9, median STS score of 1.55 (0.8, 4.0; range 0.1-91.1) and

Table 1. Demographic characteristics, comorbidities, electrocardiography(ECG), coronarography and other diagnostic procedures conducted in the preoperative period in groups of OPEN coronary artery bypass graft (CABG) and minimally invasive (MICS) CABG operations

Variable		OPEN CABG (N=122)	MICS CABG (N=115)	p
Gender (No, %)	Female	33 (27.1)	22 (19.2)	>0.05
	Male	89 (72.9)	93 (80.8)	
Age (mean ±SD) (years)		65.0±8.6	64.7 ± 8.9	>0.05
BMI (mean ±SD) (kg/m^2)		29.2±4.1	27.7 ±3.8	>0.05
STS score (median; 25^{th}, 75^{th} percentile) (%)		1.8 (0.8, 4.4)	1.3 (0.8, 3.6)	>0.05
STS short term risk (median; 25^{th}, 75^{th} percentile) (%)		13.6 (7.8, 31.3),	9.6 (5.8, 18.9)	>0.05
Comorbidity (No, %)	Diabetes mellitus	47 (38.5)	52 (45.2)	N/A
	HTA	119 (97.5)	107 (93.0)	N/A
	HLP	98 (80.3)	78 (67.8)	N/A
	CKD	7 (5.7)	9 (7.8)	N/A
	COPD	15 (12.3)	19 (16.5)	N/A
	PVD	39 (31.9)	32 (27.8)	N/A
ECG changes* (No, %)	Sinus rhythm	111 (90.9)	106 (92.1)	N/A
	Atrial fibrillation	4 (3.2)	5 (4.3)	N/A
	AV block second or third degree	6 (4.9)	0	N/A
	RBBB	4 (3.2)	2 (1.7)	N/A
	LBBB	7 (5.7)	7 (6.0)	N/A
CAD (No, %)	Single-vessel disease	7 (5.7)	19 (16.5)	N/A
	Double-vessel disease	19 (15.6)	49 (42.6)	N/A
	Triple-vessel disease	96 (78.7)	47 (40-9)	N/A
ECHO (mean ±SD)	EF (%)	43.4±9.9	40.3±12.1	>0.05
	TAPSE (mm)	18.0±22.6	16.0±11.0	>0.05
	LVIDd (mm)	53.1±9.9	52.6±11.4	>0.05
	LVIDs (mm)	37.9±9.5	37.9±10.5	>0.05
	AR diameter (mm)	28.6±11.2	22.2±14.3	>0.05
	MV diameter (mm)	37±11.7	32±10.79	>0.05
	TV diameter (mm)	35±3.5	33±3.1	>0.05
	PAP (mmHg)	15.9±22.0	14.4±24.8	>0.05

BMI, body mass index; STS, The Society of Thoracic Surgery Risk Score; N/A, not applicable; HTA, hypertension; HLP, hyperlipidemia; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; PVD, peripheral vascular disease; RBBB, right bundle branch block; LBBB, left bundle branch block; TAPSE, tricuspid annular plane systolic excursion; LVIDs, left ventricular internal diameter end systole; LVIDs, left ventricular internal diameter end diastole; AR, aortic root; MV, mitral valve; TV, tricuspid valve; PAP, pulmonary artery pressure;
*Some patients had multiple ECG changes - the total sum exceeds the number of patients

Table 2. Procedure, mechanical ventilation, intensive care unit (ICU) and hospitalization duration; postoperative drainage, usage of blood derivatives and cardiopulmonary resuscitation (CPR) after the procedure among groups of open heart (OPEN) coronary artery bypass graft (CABG) and minimally invasive (MICS) CABG operations

Variable		**OPEN CABG** (N=122)	**MICS CABG** (N=115)	p
Procedure duration (mean ±SD) (hours)		3.5±0.8	2.8±0.8	<0.001
Mechanical ventilation duration (mean ±SD) (hours)		17.3±11.9	13.0±12.5	<0.001
ICU duration (mean ±SD) (days)		3.6±2.8	2.9±1.5	0.013
Hospitalization duration (mean ±SD) (days)		7.5±3.2	7.1±4.0	>0.05
Drainage (mean ±SD)	1st hour	82.5±55.2	100.1±68.2	>0.05
	2nd hour	138.0±80.7	139.0±100.5	>0.05
	6th hour	315.0±232.7	241.8±208.1	>0.05
	24th hour	652.0±324.0	354.±248.7	<0.001
	48th hour	1062.8±920.2	513.0±310.1	<0.001
Usage of blood derivative (No)	Red blood cells (yes/no)	292 doses	55 doses	N/A
	Plasma (yes/no)	270 doses	86 doses	N/A
	Platelets (yes/no)	71 doses	28 doses	N/A
CPR (No, %)	Asystole/PEA (yes/no)	9 (7.4%)	3 (2.6%)	N/A
	VF/VT (yes/no)	7 (5.7%)	2 (1.7%)	N/A

ICU, intensive care unit; CPR, cardiopulmonary resuscitation; PEA, pulseless electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia; N/A, not applicable

short term STS score of 11.2 (6.8, 23.7) were noticed. Mean age of all patients was 64.8±8.7 (ranging from 41 to 83) years. When comorbidities were considered, hypertension was found among 226 (95.3%) patients, diabetes mellitus among 97 (41.7%), hyperlipidaemia among 176 (74.2%), chronic renal disease among 16 (6.7%), chronic obstructive pulmonary disease among 34 (14.3%), and peripheral vascular disease among 71 (29.9%) patients. There was no statistical significance (p>0.05) in the occurrence of certain entity between the groups of OPEN CABG and MICS CABG (Table 1).

The mean procedure duration was 3.3±0.8 hours (OPEN 3.5±0.8 hours; MICS 2.8±0.8 hours) (p<0.001). Patients undergoing OPEN CABG generally required mechanical ventilation for 17.3±11.9 hours, whereas MICS CABG required it for 13.0±12.5 hours (p<0.001). Even though there was no difference in total hospitalization length between groups OPEN (7.5±3.2) VS MICS (7.1±4.0), patients receiving MICS (2.9±1.5) spent less time in the intensive care unit (ICU) (p=0.0013) than OPEN CABG (3.6±2.8) patients. There was no difference in postoperative wound drainage during the first 6 hours between the groups (p>0.05), but during 24h (OPEN 652.0±324.0 vs MICS 354.±248.7) and 48h (OPEN 1062.8±920.2 vs MICS 513.0±310.1) a statistical significance (p<0.001) was observed. OPEN CABG used also much more blood derivatives, red blood cells (OPEN 292 vs MICS 55), plasma (OPEN 270 vs MICS 86) and platelets (OPEN 71 vs MICS 28), compared to MICS CABG. Patients receiving MICS had fewer CPR (MICS 4.3% vs OPEN 13.1%) (Table 2).

DISCUSSION

To the best of our knowledge, this is the first research in Bosnia and Herzegovina comparing different CABG approaches, open surgery vs minimally invasive surgery, their advantages, results, and future prospects. It provided information about current CABG approaches in the country where coronary artery disease and other heart conditions are the most prevalent both in mortality and morbidity. The majority of patients included in the study were male, with a mean age of 64.8±8.7 years, overweight, with various comorbidities such as hypertension, diabetes mellitus, hyperlipidaemia, chronic obstructive pulmonary disease, and peripheral vascular disease. Our study showed that MICS CABG took less time to conduct, less mechanical ventilation hours and less ICU duration compared to OPEN CABG even though the hospitalization duration was very similar. MICS CABG had also fewer CPRs postoperatively, used less blood derivatives including red blood cells, plasma and platelets and had less postoperative drainage at 24 and 48 hours than OPEN CABG.

Compared to similar studies (13-16) that observed the same surgical techniques, our study had similar results regarding hospital stay and blood derivate transfusions. Even though our study showed similar hospitalization time between both groups due to our institution protocols, ICU duration was much shorter among the gro-

up of MICS CABG, which could be attributed to fewer wound infections, faster recovery and less blood loss. The Rabindranauth (14) research included a comparable single surgeon cohort of MICS CABG patients, who had similar short-term results and a lower duration of stay when propensity matched with open CABG patients. Researches regarding procedure length vary from longer MICS CABG (17) to shorter (18) compared to OPEN CABG. This difference is explained in longer operative time during the learning curve, and shorter after the technique is learned. Also, surgical human factors could be attributed, but single surgeon cohort studies (14) prove that in general MICS CABG takes less time to be conducted than OPEN CABG. Our results are in accordance with these studies (14-17). Shorter mechanical ventilation time among patients undergoing MICS CABG was observed in the Birla et al. (19) and Lichtenberg et al. studies (20), which was shown in our study and it is attributed to faster recovery, less blood loss, shorter procedure time and probably less postoperative pain and blood derivatives usage (21).—Less wound drainage, which was proved in our study after 24h and 48h, shows faster wound healing and general recovery due to smaller surgical approach, less structures being affected due to the procedure and more precise technique (21). -

Our study had several limitations. Firstly, the study included only data from one cardiac surgery centre in the country. Future studies should include all cardiac surgery centres in the country. Secondly, the study did not include patients who were converted from one operative technique to the other during the operation. Future studies should also incorporate this group to analyse operative complications, success rate in finalizing MICS CABG and possible improvements both in preoperative and postoperative way to minimize this phenomenon. Studies should also include a postoperative doctor-patient questionnaire which analyses subjective feeling among patients undergoing these procedures.

In conclusion, patients undergoing MICS CABG in Bosnia and Herzegovina have had less mechanical ventilation hours and less ICU duration compared to OPEN CABG even though the hospitalization duration was very similar. MICS CABG uses less time to be conducted, has fewer CPRs postoperatively, used less blood derivatives including red blood cells, plasma and platelets and had less postoperative drainage at 24 and 48 hours than OPEN CABG. This technique offers many benefits to the patient, medical-healthcare system and offers better outcomes.

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TRANSPARENCY DECLARATION

Competing interests: None to declare.

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