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Sex-specific outcome after minimally invasive direct coronary artery bypass for single-vessel disease: a propensity score matching analysis

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Abstract

Objective To evaluate the influence of gender on surgical outcome in patients with single-vessel disease undergoing minimally invasive direct coronary artery bypass (MIDCAB).

Methods This retrospective, non-randomized study analyzed 471 patients who underwent MIDCAB between February 2012 and January 2021 through left lateral thoracic small incision in the Department of Cardiac Surgery of our hospital were selected. Data were collected on demographics, clinical characteristics, operative and postoperative outcomes, and follow-up mortality and morbidity. Propensity score matching (PSM) was used to match patients between the groups.

Results Before matching, female patients were older, had higher incidence of DM (40.2% Vs 27.3%, $p=0.013$), higher LVEF (66.7 ± 8.0 Vs 63.6 ± 10.1, $p<0.001$) and smaller LVEDD (4.7 ± 0.5 Vs 5.1 ± 0.6, $p=0.001$). After matching, the differences in baseline characteristics between both groups were eliminated. PS matching selected 103 matched pairs for final comparison. No significant differences were observed between both groups in terms of in-hospital mortality, the incidence of MACCE, incidence of perioperative MI, incidence of stroke, reoperation for bleeding. Female patients had longer length of stay compared to male patients (18.9 ± 14.3 Vs 15.5 ± 5.9, $p=0.027$).

Conclusion Female sex is not connected with higher risk of mortality or other major events in MIDCAB. Wound healing complications remain the leading attribute associated with female sex.

Keywords MIDCAB, Off-pump coronary aortic bypass grafting, Sex differences, Propensity score matching

Introduction

Coronary artery disease (CAD) has been the leading cause of death in the elderly population over the last century [1, 2]. Within a wide scale of treatment options, coronary artery bypass grafting (CABG) is the most effective for a selected group of patients [3]. Knowledge about gender-specific differences in heart disease has increased considerably, and increased morbidity and mortality rates in women after coronary artery bypass grafting (CABG) have been reported [4–6].

Little is known regarding gender-associated outcome after minimally invasive direct coronary artery bypass (MIDCAB). MIDCAB offers minimally invasive arterial coronary revascularization without cardiopulmonary bypass, specifically for isolated lesions of the left anterior descending (LAD) coronary artery [7].

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The aim of this study was to evaluate gender-based early-term results in patients with single-vessel disease following MIDCAB.

Materials and methods

Study design

This study is a single-centered, retrospective, non-randomized study including 471 patients who underwent a MIDCAB operation between February 2012 and January 2021 in our hospital.

To reduce the risk of selection bias inherent to a retrospective, observational studies, a propensity score (PS) matching was used to match patients between the groups. PS were generated from a multivariable logistic regression model based on six preoperative variables: age, body mass index (BMI), diabetes mellitus (DM), hypertension, hyperlipoproteinemia, previous myocardial infarction (MI), left ventricular ejection fraction (LVEF), left ventricular end-diastolic dimension (LVEDD), previous percutaneous coronary intervention (PCI), peripheral vascular diseases (PVD). Patients were then matched in 1:1 fashion using a caliper matching method without replacement with a caliper width of 0.2 SD of the logit of the PS [8, 9].

Inclusion criteria—population

Every patient who underwent a MIDCAB operation at our hospital between February 2012 and January 2021 was eligible for this study. Both elective, urgent, and emergent cases were included in the present study. The decision to perform a MIDCAB operation was individualized for each patient based on the coronary anatomy and was made at the surgeons' discretion, always in accordance with the latest guidelines, our institutional multidisciplinary Heart Team decision, and patients' informed consent.

Operative technique

Under general anesthesia and with single-lumen intubation, the patient was placed on the operating table in a supine position with a slightly elevated left scapula. A small (5–8 cm) anterolateral thoracotomy was performed in the left fourth or fifth intercostal space based on the coronary anatomy and surgeons' discretion. A specialized rib retractor (Thoralift™ and, in the most recent cases, Mutistation™, LSI Solutions, Victor, NY, USA) was selected to partially elevate the rib cage to achieve better visibility during LIMA harvesting. In order to achieve a sufficient length to reach the coronary artery without tension, the artery was mobilized to the highest possible level (up to the subclavian vein). Heparin was administered intravenously until the target PTT of >300 s had been reached. A stabilization device (Octopus™, Medtronic, Minneapolis, MN, USA) was positioned to expose the LAD, and a longitudinal incision was made in the coronary artery. The LIMA graft was carefully prepared for the bypass. A shunt was placed into the coronary vessel and the end-to-side anastomosis was performed with 7/0 polypropylene (Prolene™) suture in a running fashion. The shunt was removed, and the anastomosis was completed. The bulldog clamp was removed from the LIMA and the coronary flow was restored. Heparin was reversed and after completing the flow measurement, the wound was closed in anatomic layers. The patient was delivered intubated to the intensive care unit to be extubated in the following hours.

Data acquisition

In accordance with the data protection regulations, demographic information, clinical characteristics, and operative and postoperative data were retrospectively extracted from the institutional medical records of the included patients. Telephone interviews with the patients or/and their relatives or/and their primary care physicians were performed for an active follow-up.

Due to the retrospective, observation nature of the study, the requirement for informed consent was deferred. This study was performed in accordance with the Declaration of Helsinki, and the data regarding the patient's identity remained strictly anonymous. Ethical approval was obtained from the Ethics Committee of People's Hospital of Peking University. All methods utilized in the present study were performed in accordance with regulations and guidelines.

Statistical analysis

The obtained data were entered into a dedicated Microsoft Excel spreadsheet. Statistical analysis was performed using IBM SPSS version 26 (IBM Corp., Chicago, IL, USA). Data were tested for normality using the Shapiro–Wilk test. When the data were not normally distributed, continuous variables were expressed as medians (interquartile range, IQR) or as mean ± standard deviation. Survival curves were generated using the Kaplan–Meier method. Categorical variables were expressed as frequencies and percentages.

Results

Baseline characteristics

Baseline characteristics of the unadjusted and PS adjusted populations are presented in Table 1. In the unadjusted study groups, female patients were older, had higher incidence of diabetes mellitus (DM), higher left ventricular ejection fraction (LVEF) and smaller left ventricular end-diastolic dimension (LVEDD). After performing PS matching, the differences in baseline characteristics between both groups were eliminated (Table 1). Although there were significant differences in height and

Table 1 Baseline characteristics

	Before matching			After matching		
	Female (*N* = 112)	Male (*N* = 359)	*P*	Female (*N* = 103)	Male (*N* = 103)	*P*
Age	63.2 ± 9.9	60.9 ± 10.3	0.034	62.9 ± 10.1	62.3 ± 9.4	0.622
Height, cm	158.0 ± 5.1	169.7 ± 5.8	<0.001	158.3 ± 4.9	168.3 ± 5.9	<0.001
Weight, Kg	62.4 ± 9.7	73.8 ± 10.6	<0.001	62.7 ± 9.4	70.7 ± 10.5	<0.001
BMI	25.0 ± 3.5	25.5 ± 3.4	0.144	25.0 ± 3.4	24.9 ± 3.2	0.777
DM	45(40.2%)	98(27.3%)	0.013	39(37.9%)	43(41.7%)	0.669
Hypertension	77(68.8%)	201(56.0%)	0.106	73(70.9%)	63(61.2%)	0.185
Hyperlipoproteinemia	26(23.2%)	62(17.3%)	0.322	23(22.3%)	15(14.6%)	0.208
PVD	14(12.5%)	56(15.6%)	0.543	12(11.7%)	14(13.6%)	0.834
COPD	3(2.7%)	9(2.5%)	1.000	3(2.9%)	0(0%)	0.246
Previous MI	21(18.8%)	79(22.0%)	0.510	19(18.4%)	23(22.3%)	0.604
Previous PCI	25(22.3%)	83(23.1%)	0.898	23(22.3%)	28(27.2%)	0.519
Previous stroke	15(13.4%)	43(12.0%)	0.742	15(14.6%)	9(8.7%)	0.277
Chronic renal insufficiency	5(4.5%)	13(3.6%)	0.777	4(3.9%)	6(5.8%)	0.748
LVEF, %	66.7 ± 8.0	63.6 ± 10.1	<0.001	66.8 ± 8.1	65.1 ± 9.9	0.221
LVEDD, cm	4.7 ± 0.5	5.1 ± 0.6	0.001	4.7 ± 0.4	4.7 ± 0.5	0.878
NYHA class III or IV	22(19.6%)	51(14.2%)	0.249	21(20.4%)	24(23.3%)	0.736

BMI, body mass index; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; LVEF, left ventricular ejection fraction; LVEDD, left ventricular end-diastolic dimension; MI, myocardial infarction; NYHA, New York Heart Association; PCI, percutaneous coronary intervention; PVD, peripheral vascular diseases

Table 2 Operative and in-hospital outcomes

Parameter	Female (*N* = 103)	Male (*N* = 103)	*P*
TTFM, ml/min	19.3 ± 15.4	22.8 ± 14.0	0.174
PI	2.8 ± 1.1	2.5 ± 0.9	0.063
Perioperative IABP	1(1.0%)	2(1.9%)	1.000
Initial ventilator time, hours	12.3 ± 18.5	9.3 ± 12.3	0.174
ICU stay, hours	41.9 ± 51.8	32.8 ± 32.3	0.133
Length of stay, days	18.9 ± 14.3	15.5 ± 5.9	0.027
Drainage volume, ml	796.1 ± 556.0	879.1 ± 617.9	0.313
Blood transfusion	34(33.0%)	21(20.4%)	0.058
Blood transfusion, Units	4.8 ± 4.3	5.7 ± 3.7	0.437
New onset AF	5(4.9%)	5(4.9%)	1.000
Max CK-MB	7.5 ± 26.2	8.9 ± 30.5	0.721
Max TnI	1.8 ± 7.3	1.7 ± 8.9	0.927
Perioperative MI	3(2.9%)	3(2.9%)	1.000
Stroke	2(1.9%)	1(1.0%)	1.000
Postoperative LAD intervention	2(1.9%)	0(0%)	0.498
Re-exploration for bleeding	1(1.0%)	0(0%)	1.000
Death	2(1.9%)	1(1.0%)	1.000
MACCE	5(4.9%)	3(2.9%)	0.721

AF, atrial fibrillation; CK, creatine kinase; IABP, intra-aortic ballon pump; ICU, intensive care unit; LAD, left descending artery; MACCE, major adverse cardiovascular and cerebrovascular event; MI, myocardial infarction; PI, plasticity index; TTFM, transient time flow measurement

weight, no difference in BMI. PS matching selected 103 matched pairs for final comparison.

Operative and in-hospital outcomes

After the PS matching, no significant differences were observed between both groups in terms of in-hospital mortality, the incidence of major adverse cardiovascular and cerebrovascular event (MACCE), incidence of perioperative MI, incidence of stroke, reoperation for bleeding. However, female patients had longer length of stay compared to male patients (Table 2).

Discussion

An ongoing controversy exists regarding the role of gender differences in surgical outcomes after CABG, and it remains uncertain whether being female is an independent risk factor for postoperative death [10].

This retrospective, single-center study aimed to compare short-term clinical outcomes of MIDCAB in different sex patients with single-vessel, LAD stenosis. The results confirm the safety and effectiveness of this strategy in patients with single-vessel LAD disease. In this study, early postoperative results showed comparable outcomes between both groups in terms of mortality, incidence of MACCE, perioperative MI, stroke. However, male patients experienced quicker recovery and shorter hospital stay when compared to female group.

Before matching, female patients were older and had higher incidence of DM than males. This observation was also made by other authors who analysed gender-specific characteristics in patients with coronary artery disease [6, 11]. However, after matching, there were no differences both in age and incidence of DM. Regarding wound healing complications in female patients, there is some evidence showing a higher rate of wound complications in MIDCAB [12]. In our study, there is a relatively high rate of slow wound healing in females, because of the compression of breast. Although less of them required added surgical treatment, higher attention should be given to

wound care in females after MIDCAB. Besides, it seems to be many postoperative blood transfusions both in two groups. Some patients were diagnosed as myelodysplastic syndromes (MDS) combined with CAD require CABG before bone marrow transplantation. These patients have severe anemia and thrombocytopenia, so they needed more postoperative blood transfusions.

There are less studies up-to-date observing sex differences in MIDCAB. The approach may be more challenging for the surgeon in females because of location under the left breast. It may be related to manipulation problems during the procedure itself, which could result in longer surgery times. Nonetheless, the difficulty of approach did not result in higher risk of conversion or any other major adverse events.

Limitations

Our study has some limitations. It was constructed as a retrospective study, and only early-term data were obtained. Because of the smaller study size, some differences could not achieve statistical significance notably. That makes any further analysis of short-term mortality statistically irrelevant. Furthermore, for the same reasons, future application of our statistical models is inappropriate, as proven above by the low coefficient of determination values. Further studies are needed to accumulate more knowledge about short- and long-term and sex differences in MIDCAB settings.

Conclusion

This study demonstrated MIDCAB as a safe method for revascularization of the LAD in females and males with single-vessel disease. There is no proven higher mortality in females undergoing MIDCAB. Adequate attention should be given to wound care in women undergoing MIDCAB because of possibly higher risk of slow wound healing. Further research is needed to validate these findings through prospective, multi-center trials to overcome limitations associated with retrospective analyses.

Author contributions

Hao Ma and Zhou Zhao wrote the main manuscript text and Fengbo Pei prepared Tables 1 and 2. All authors reviewed the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Competing interests

The authors declare no competing interests.

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