

# Primary and repeated coronary artery bypass grafting using minimally invasive extracorporeal circulation

## Summary

Although most coronary artery bypass grafting (CABG) operations are performed through middle sternotomy using extracorporeal circulation, minimally invasive myocardial revascularization is increasingly being used in myocardial revascularization. Minimally invasive coronary artery bypass grafting is a revolutionary trend in cardiac surgery. Thanks to the use of modern high-tech means, patients with coronary heart disease undergo multiple coronary artery bypass grafting without extracorporeal circulation through a left-sided minithoracotomy. Minimally invasive cardiac surgery Coronary Artery Bypass Grafting (MICS CABG) is an attractive, possibly more suitable method than classic CABG, accompanied by minimal complications. This technique is safe, effective, and provides outstanding patient comfort and the possibility of safe re-access in the future, when myocardial ischemia returns. This technique provides good long-term results, comparable to conventional CABG. However, there is a group of patients in whom it is impossible to safely perform this operation (relative insufficiency of heart valves, cardiac arrhythmia, low ejection fraction of the left ventricle). These patients can undergo CABG using minimally invasive extracorporeal circulation.

**Purpose:** The aim of the study was to demonstrate the first experience of using the MiECC technique in MICS CABG with the assessment of hospital outcomes.

**Material and methods:** From January 2015 to January 2023, 89 mini-invasive CABG surgeries were performed in our department through left-sided mini-thoracotomy, of which seven operations were performed using a minimally invasive extracorporeal circuit of the first type.

**Outcomes:** In the group with MiECC in MICS CABG, there were no myocardial infarctions or deaths.

**Conclusion:** The use of MiECC in MICS provides good in-hospital outcomes and can be used as a safe alternative for myocardial revascularization in primary and recurrent patients with CAD.

**Keywords:** coronary bypass surgery; thoracotomy, extracorporeal circulation, MICS CAB

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## Introduction

The “gold standard” of coronary surgery is CABG through sternotomy in the conditions of extracorporeal circulation (ECC). The mortality rate with this technique is 1-2%, but the total frequency of postoperative complications reaches 20-25% (pneumonia, wound infection, myocardial infarction and stroke). In this regard, over the past twenty years, there has been a desire in coronary surgery to reduce surgical trauma (minimally invasive approaches) and reduce the ECC-associated systemic inflammatory response that determines hemostasis disorders and multiple organ failure.<sup>1,2</sup> Minimally invasive coronary artery bypass grafting through left mini-thoracotomy is a relatively new CABG technology that has already shown good results.

Joseph T. McGinn and colleagues began operating in 2005, and the first results are reflected in a 2009 paper, n=450. Five years later, at a congress in Boston, the results of the operation were reported in 1038 patients with good results.<sup>3</sup> The combination of minimally invasive cardiac surgery with a conventional contour reduces the number and severity of postoperative complications due to the integrity of the sternum, but does not save from ECC-associated complications. Performing CABG on a beating heart is not always possible and safe,

and 10% of MICS CAB require ECC support.<sup>4,5</sup> An alternative method is the technique of minimally invasive extracorporeal circulation (MiECC), which is devoid of the disadvantages of conventional ECC.

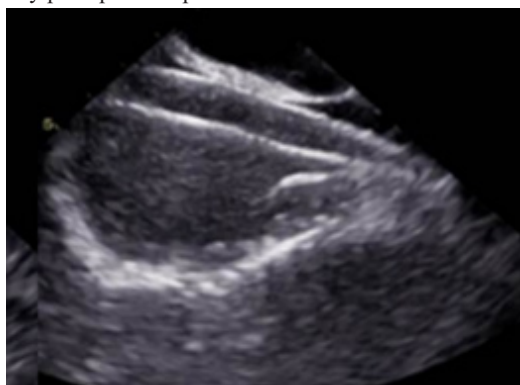
**The aim** of the study was to demonstrate the first experience of using the MiECC technique in MICS CABG with the assessment of hospital outcomes.

## Material and methods

From January 2015 to January 2023, 89 MICS CABG operations were performed in our department through left-sided mini-thoracotomy, of which 48 in primary patients and 41 in previously operated patients. The mean age of patients was 62.5±6.3 years; 88.8% men, 11.2% women. Most of the cases were males over 60 years of age. According to the Canadian classification, all patients had angina pectoris III-IV f.c. Most of the patients had a history of MI (52 (58.4%)), the mean fraction of expulsion of the left ventricle was 55.7±5.4%, CABG without ECC was performed in 56 (63%) patients. In 33 (37%) patients, the operation was performed with classical parallel ECC through the common femoral artery and vein.

## Outcomes

In 7 patients, the operation was performed in an infrared setting using a semi-closed minimally invasive extracorporeal circuit of the first type, which consists of a venous trunk, a centrifuge pump, an oxygenator, and an arterial trunk. The cardiectomy reservoir on the venous line is semi-flowing: wound blood can periodically return to a closed circuit or to the patient's cardiovascular system after treatment in a blood separator. We used a peripheral (femoral artery-femoral vein) circuit connection under the control of ultrasound of the heart (Figure 1 and 2). These patients with multivessel lesions of the coronary bed underwent 20 anastomoses under conditions of parallel normothermic ECC with full volumetric velocities ( $2.0\text{--}2.2\text{ l/min/m}^2$ ) and in auxiliary mode. In all cases, the full design perfusion rate was achieved. The average time of the ECC was 98 minutes, during which there was no abnormal course of the procedure. After performing anastomoses and completing hemostasis, the ECC was turned off at therapeutic doses of inotropic support. The duration of the operation was  $354\pm 90$  minutes. Intraoperative blood loss was  $339\pm 128$  ml. The average time of mechanical ventilation after surgery was just over 4,5 hours. The ventilation time was 16 hours; all patients were transferred from the ICU in 24 hours to the specialized unit and discharged from the hospital on the 7th day after surgery. In the group with MiECC in MICS CABG, there were no myocardial infarctions or deaths. All patients ( $n=89$ ) were admitted to the ICU after surgery, where the state of central hemodynamics, the severity of heart failure, the duration of mechanical ventilation, doses of inotropic support, and the time spent in the department were assessed. According to the results, postoperative mortality was 2.2%, the incidence of type 5 MI was 3.3%, stroke was 1.1%, acute respiratory failure and heart failure were 5.5% and infectious complications were 3.3%. In general, the course of the early postoperative period was favorable.



**Figure 1** Control of the venous cannula in the right atrium by transesophageal echocardiography.



**Figure 2** Peripheral cannulation.



**Figure 3** Redo minimally invasive cardiac surgery coronary artery bypass grafting through a left thoracotomy.

The normal course of the perfusion period indicates the safety of the technique even during the learning period. The uncomplicated course of the postoperative period in most patients indicates the effectiveness of the technique. More research is needed to establish reliable benefits.

### Advantages of MICS CAB:

- Less need for blood transfusions during and after surgery;
- Less pronounced pain syndrome in the postoperative period;
- No risk of wound infection;
- Shorter duration of hospitalization;
- Intact sternum and complete preservation of the frame integrity of the chest;
- Short recovery period.

### Advantages of MiECC:

- Minimum hemodilution (primary filling volume –20% of the blood volume);
- Exclusion of blood transfusion;
- Minimal systemic inflammatory and coagulation response (reduction of the contact surface, exclusion from the circulation of wound blood);
- Active venous drainage allows the use of smaller diameter cannulas to ensure full volumetric perfusion rate;
- Minimal microembolic load.

The introduction of this method into wide clinical practice contributes to a significant reduction in wound, neurological, cardiac, vascular, respiratory complications of surgical intervention, a significant reduction in mortality, as well as a reduction in treatment costs associated with a reduction in the duration of the patient's stay in the intensive care unit and a reduction in the total bed day. The absence of total sternotomy has a positive effect on the mechanics of breathing in the postoperative period.

## Findings

The MICS CAB technique with and without MiECC is safe, effective, provides greater comfort for the patient and in the future a safe re-access during the return of myocardial ischemia. Low trauma and high efficiency of the method allow us to consider it as a useful alternative to standard CABG.

## Conflict of interest

Conflict of interest is not declared.

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## References

1. Bokeriya LA, Berishvili II, Sigaev IYu. Current trends and prospects for the development of coronary surgery. *Ann Hirurgii*. 1997;4:31–45. (In Russian).
2. Shabalkin BV. Past, present and future in the surgical treatment of coronary heart disease. *Ann RNCH RAMN*. 1998;7:159–162. (In Russian).

3. McGinn JT, Usman S, Lapierre H, et al. Minimally invasive coronary artery bypass grafting: dual center experience in 450 consecutive patients. *Circulation*. 2009;120:S78–S84.
4. Averina TB, Sigaev IYu, Kazaryan AV. Coronary bypass surgery using minimally invasive extracorporeal circulation. In: Practice Oriented Science: UAE - RUSSIA - INDIA. Proceedings of the International University Scientific Forum. UAE; 2023:64–67.
5. Sigaev IYu, Kazaryan AV, Starostin MV, et al. Repeated coronary bypass surgery by MICS and MIDCAB: analysis of your own results and world experience. *Russ J Thorac Cardiovasc Surg*. 2021;63(1).
6. Ellam S, Räsänen J, Hartikainen J, et al. Impact of minimal invasive extracorporeal circulation on perioperative intravenous fluid management in coronary artery bypass surgery. *Perfusion*. 2023;38(1):135–141.
7. Rufa M, Schubel J, Ulrich C, et al. A retrospective comparative study of minimally invasive extracorporeal circulation versus conventional extracorporeal circulation in emergency coronary artery bypass surgery patients: a single surgeon analysis. *Interact Cardiovasc Thorac Surg*. 2015;21(1):102–107.