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IMMEDIATE OUTCOMES OF CORONARY ARTERY BYPASS GRAFTING THROUGH MINITHORACOTOMY IN PATIENTS WITH ISCHEMIC HEART DISEASE

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Abstract

Ischemic heart disease remains one of the most important clinical problems in cardiovascular medicine. In patients with multivessel coronary artery disease, left main coronary artery involvement, and complex coronary lesions associated with diabetes mellitus, coronary artery bypass grafting remains an important method of myocardial revascularization. Although conventional median sternotomy provides wide surgical exposure, it is associated with operative trauma, blood loss, sternal wound complications, postoperative pain, respiratory limitation, and prolonged rehabilitation. For this reason, interest in minimally invasive approaches such as minithoracotomy, MIDCAB, MICS-CABG, robotic coronary surgery, and hybrid coronary revascularization has increased in recent years.

This review critically analyzes the immediate outcomes of coronary artery bypass grafting performed through minithoracotomy in patients with ischemic heart disease. Current evidence shows that the most consistent advantages of minimally invasive coronary surgery are observed in the early postoperative period, including reduced blood loss and transfusion requirements, shorter ventilation time, shorter intensive care unit stay, and reduced overall hospitalization. However, a clear superiority over conventional sternotomy in terms of 30-day mortality, perioperative myocardial infarction, stroke, and long-term major adverse cardiovascular and cerebrovascular events has not yet been conclusively proven. The effectiveness of this approach depends strongly on patient selection, coronary anatomy, completeness of revascularization, surgeon experience, and institutional capability.

Keywords: ischemic heart disease, coronary artery bypass grafting, minithoracotomy, MIDCAB, MICS-CABG, minimally invasive cardiac surgery, immediate outcomes.

Introduction

Ischemic heart disease is one of the leading causes of mortality, disability, and reduced quality of life worldwide. Atherosclerotic narrowing of the coronary arteries limits oxygen delivery to the myocardium and may lead to angina pectoris, myocardial infarction, heart failure, and loss of working capacity. Therefore, treatment of ischemic heart disease is not limited to symptom control; it also aims to improve long-term prognosis.

Current clinical guidelines emphasize that the choice of coronary revascularization strategy should be based on the patient's individual risk profile, coronary anatomy, left ventricular function, presence of diabetes mellitus, anatomical complexity, and surgical risk [1,2]. Thus, the central question in modern cardiac surgery is not simply "which procedure is better?", but rather "which procedure is most appropriate for this particular patient?"

Coronary artery bypass grafting is an important treatment option in multivessel coronary artery disease, left main coronary artery disease, and complex anatomical lesions. Conventional CABG is usually performed through median sternotomy. This approach provides excellent exposure of the heart and great vessels and allows complete multivessel revascularization. However, full sternotomy is associated with surgical trauma, bleeding, pain, sternal wound infection, respiratory limitation, and prolonged rehabilitation.

Minimally invasive coronary surgery developed as a response to these limitations. The main goal of minithoracotomy, MIDCAB, and MICS-CABG is to reduce operative trauma while preserving the quality of myocardial revascularization. However, a smaller incision alone does not guarantee better clinical outcomes. The true value of the technique should be assessed using objective endpoints such as 30-day mortality, perioperative myocardial infarction, stroke, bleeding, transfusion requirement, postoperative atrial fibrillation, duration of mechanical ventilation, intensive care unit stay, hospital stay, conversion rate, and graft patency.

Aim of the Review

The aim of this article is to critically analyze the immediate outcomes of coronary artery bypass grafting performed through minithoracotomy in patients with ischemic heart disease, to identify the strengths and limitations of current evidence, and to provide a scientific basis for future clinical studies in local practice.

Materials and Methods

This article was prepared as a narrative-critical review. The literature search included PubMed, PubMed Central, PLOS ONE, JTCVS Techniques, JTCVS Open, Frontiers in Cardiovascular Medicine, MDPI, AHA/ACC guideline sources, and relevant journal websites. The following search terms were used: "minimally invasive coronary artery bypass grafting," "MICS-CABG," "MIDCAB," "left anterior minithoracotomy," "mini-sternotomy CABG," "off-pump minimally invasive CABG," "hybrid coronary revascularization," "postoperative outcomes," "graft patency," "ICU stay," and "atrial fibrillation."

Terminological Clarification

Several terms are used in minimally invasive coronary surgery. Treating them as identical may lead to methodological errors.

MIDCAB refers to minimally invasive direct coronary artery bypass, usually performed through a left anterior minithoracotomy and most commonly involving LIMA/LITA-to-LAD grafting. It is mainly used in isolated or dominant LAD disease [3,4].

MICS-CABG refers to coronary artery bypass grafting performed through a left minithoracotomy. Unlike MIDCAB, it may include multivessel revascularization in selected patients [5,6].

Mini-sternotomy is a limited sternal incision approach. It differs from minithoracotomy because the sternum remains partially involved in the surgical access.

Hybrid coronary revascularization combines surgical LIMA/LITA-to-LAD grafting with PCI of other coronary vessels [7].

Table 1. Minimally Invasive Coronary Revascularization Approaches

Approach	Surgical access	Main indication	Main strenght	Limitation
MIDCAB	Left anterior minithoracotomy	LAD disease	Durable LIMA/LITA–LAD graft	Mostly single-vessel disease
MICS-CABG	Left minithoracotomy	Selected multivessel disease	Avoids sternotomy	Technically demanding
Mini-sternotomy	Limited sternal incision	Single- or multivessel CABG	Relatively good exposure	Partial sternal trauma
Hybrid revascularization	Surgery + PCI	LAD and non-LAD lesions	Individualized strategy	Cost and logistics
Robotic/TECAB	Ports or robotic access	Selected patients	Minimal tissue trauma	High cost and steep learning curve

Scientific and Biological Rationale

The theoretical advantage of minimally invasive CABG is related to reduced surgical trauma. Median sternotomy causes substantial injury to bone and soft tissues. This may lead to pain, respiratory limitation, bleeding, systemic inflammatory response, and prolonged rehabilitation.

In minithoracotomy-based approaches, the sternum is preserved, chest wall stability is better maintained, and early mobilization may be easier. Therefore, shorter ventilation time, reduced ICU stay, and shorter hospitalization are biologically plausible outcomes. However, this theoretical advantage does not always translate into superiority in major clinical endpoints such as mortality, stroke, myocardial infarction, or MACCE [5,8].

Criteria for Assessing Immediate Outcomes

Table 2. Main Clinical Endpoints for Immediate Outcomes

Endpoint	Clinical meaning
30-day mortality	Overall safety of the procedure
Perioperative MI	Quality of anastomosis and myocardial protection
Stroke	Embolic risk and aortic manipulation
Bleeding	Surgical trauma and quality of hemostasis
Transfusion	Blood loss and operative stress

POAF	Inflammation, age, and structural heart status
Extubation time	Respiratory recovery
ICU stay	Early recovery and hemodynamic stability
Hospital stay	Rehabilitation and cost-effectiveness
Conversion	Technical safety and learning curve
Graft patency	Functional quality of the operation

Analysis of Current Evidence

The strongest evidence for MIDCAB is related to the long-term durability of the LIMA/LITA-to-LAD graft. In proximal LAD disease, MIDCAB may reduce the need for repeat revascularization compared with PCI [3]. In a 2024 MIDCAB series of 155 patients, 30-day mortality was 0%, 5-year overall survival was 90.5%, and revascularization-free survival was 84.2% [4]. These data support the short-term safety and mid-term effectiveness of MIDCAB.

A 2025 long-term MIDCAB analysis including 480 patients reported in-hospital mortality of 1.4% and LITA–LAD graft patency of 94.4% [9]. This suggests that the main strength of MIDCAB is not merely the smaller incision, but the biological durability of the LIMA/LITA-to-LAD graft.

Evidence for MICS-CABG is more dependent on specialized centers. In a JTCVS Techniques series of MICS-CABG performed via left anterior minithoracotomy, 30-day mortality was 0.4%; 53% of patients had triple-vessel disease and 43% had left main coronary artery disease [5]. This demonstrates that MICS-CABG can be performed even in complex coronary anatomy, but the results are highly dependent on institutional experience.

In an initial MICS-OPCAB program, 30-day mortality was 0%, POAF occurred in 18%, pleural effusion in 28%, chest infection in 8%, wound complications in 4%, ICU stay was 2±2.2 days, and hospital stay was 5.7±2.7 days [6]. These results suggest that MICS-OPCAB may be safe in selected patients, although pleural complications and atrial fibrillation are not completely eliminated.

A 2024 MIDCAB short-term outcomes series reported 0% 30-day mortality, bleeding-related complications in 4.4%, neurological events in 0%, and wound infection in 2.2% [10]. These findings further support the early postoperative safety of minimally invasive coronary surgery.

A 2026 review of MICS-CABG reported perioperative mortality generally between 0% and 1.3%, early graft patency between 92% and 100%, and 10-year survival between 79% and 84% [11]. However, the same review emphasized that randomized evidence remains limited, and existing observational results should not be interpreted as definitive proof of superiority.

Meta-Analytical Summary Table

Table 3. Main Studies and Outcomes in Minimally Invasive CABG

Author/ source	Year	Design	n	30-day/in-hospital mortality	MI/ stroke	POAF	ICU/hospital stay	Main conclusion

Margari et al.	2024	Retrospective MIDCAB	155	0%	Stroke 0%	POAF affected prognosis	Follow-up 36 months	5-year survival 90.5%; revascularization-free survival 84.2%
Aboul-Hassan et al.	2025	Long-term MIDCAB	480	1.4%	Focus on patency	-	Median follow-up 3.39 years	LITA–LAD patency 94.4%
Verevkin et al.	2025	MICS-CABG series	~233	0.4%	Perioperative MI improved with learning curve	-	-	Feasible in triple-vessel and left main disease
AlMawajdeh et al.	2025	Initial MICS-OPCAB program	50	0%	-	18%	ICU 2±2.2 days; hospital 5.7±2.7 days	Safe and feasible in selected patients
Alaj et al.	2024	MIDCAB short-term outcomes	-	0%	Neurological events 0%	-	-	Bleeding 4.4%; wound infection 2.2%
Uchimuro	2026	Review	Multiple series	0–1.3%	-	-	-	Early graft patency 92–100%; 10-year survival 79–84%
Gianoli et al.	2022	Meta-analysis	Various RCTs/c	Short- and long-term	-	-	-	MIDCAB reduces repeat revascula

			ohorts	outcomes assessed separately				rization vs PCI
Dallan et al.	2025	RCT protocol	100 planned	Results pending	Results pending	Results pending	Results pending	High-quality evidence still needed
AATS materials	2025	Trial rationale	-	-	-	-	Faster recovery possible	RCT evidence remains insufficient

Critical Analysis

The data summarized above suggest three major conclusions. First, 30-day mortality after minimally invasive CABG is low in many series, ranging from 0% to 1.4%. This indicates that the method may be safe in selected patients [4,6,9,10]. Second, LITA/LIMA–LAD graft patency is high, exceeding 94% in some series and ranging from 92% to 100% in review data [9,11]. Third, ICU stay and hospitalization may be shorter in minimally invasive groups; for example, in one MICS-OPCAB program, the mean hospital stay was 5.7 days [6].

Nevertheless, these findings require cautious interpretation. Many studies are based on single-center experience. Patients selected for minimally invasive surgery often have more favorable anatomy and lower or intermediate operative risk. This selection bias may exaggerate the apparent benefit of the technique. Therefore, randomized studies are needed to determine whether MICS-CABG is truly superior to conventional sternotomy. The MINI-CABG randomized trial protocol specifically addresses this evidence gap [12].

Bleeding and Transfusion

Reduced bleeding is one of the most consistent potential advantages of minimally invasive CABG. This is biologically plausible because the sternum is not fully divided, bony bleeding is reduced, and soft-tissue trauma is limited. However, bleeding cannot be explained by incision size alone. Antiplatelet therapy, coagulation status, renal function, operative time, off-pump or on-pump strategy, and institutional hemostasis protocols also play important roles.

Thus, the statement that minithoracotomy reduces bleeding is reasonable, but it should be interpreted conditionally. It depends on patient selection, surgical technique, and perioperative management.

Postoperative Atrial Fibrillation

Postoperative atrial fibrillation is one of the most common complications after CABG. Theoretically, a smaller surgical trauma and reduced inflammatory response may decrease the risk of POAF. However, published results are inconsistent [13].

For example, in an initial MICS-OPCAB program, POAF occurred in 18% of patients [6]. This rate appears lower than the commonly reported 20–40% range after conventional CABG, but

it should not be interpreted as definitive proof of superiority. POAF is multifactorial and depends on age, left atrial size, diabetes, hypertension, heart failure, electrolyte imbalance, and operative duration. Therefore, prevention of POAF requires comprehensive perioperative management rather than minimally invasive access alone.

Pain and Functional Recovery

Minimally invasive surgery does not always mean painless surgery. Pain after sternotomy is mainly related to bone division and chest wall instability, whereas pain after minithoracotomy may be related to intercostal nerve irritation, rib retraction, and pleural irritation [14].

Therefore, studies should assess not only mortality, ICU stay, and hospitalization, but also pain intensity, respiratory function, mobilization, return to daily activity, and quality of life. The real goal of minimally invasive cardiac surgery is not merely a smaller incision, but better postoperative recovery for the patient.

Learning Curve

The learning curve is one of the most important hidden factors affecting the outcomes of minimally invasive CABG. Median sternotomy is standardized and widely practiced. In contrast, minithoracotomy requires a narrow operative field, limited visualization, specialized instruments, and different ergonomics.

During the early phase of implementation, operative time may be longer, conversion risk may be higher, and technical difficulties may be more frequent. With increasing experience, outcomes improve. In one JTCVS Techniques series, perioperative myocardial infarction and other technical outcomes improved as experience accumulated [5]. This means that the “effectiveness of the technique” and the “experience of the center” must be evaluated separately.

Graft Quality and Completeness of Revascularization

The most important scientific question regarding minimally invasive CABG is whether an anastomosis performed through a small incision is as reliable as one performed through sternotomy. For MIDCAB, the answer is largely positive. LITA/LIMA–LAD patency is high and has been reported above 94% in some studies [9].

In multivessel disease, the issue is more complex. MICS-CABG can provide complete revascularization, but this depends on coronary anatomy, target vessel diameter, surgeon experience, and availability of specialized instruments. If the smaller access compromises complete revascularization, the early advantages of minimally invasive surgery may lose long-term value.

Local Scientific Gap

Systematic clinical data on minithoracotomy CABG in Central Asia, including Uzbekistan, remain limited. Therefore, future studies should be based on local patient cohorts. The strongest design would be a retrospective or prospective comparison between minithoracotomy and conventional sternotomy groups.

Table 4. Recommended Variables for Future Clinical Studies

Domain	Variables to assess
Demographics	Age, sex, BMI
Risk profile	EuroSCORE II, diabetes, COPD, CKD, EF
Coronary anatomy	LAD, RCA, LCx, left main, SYNTAX
Operation	Number of grafts, operative time, off-pump/on-pump
Early outcomes	Mortality, MI, stroke, POAF

Hemostasis	Drainage blood loss, transfusion, reoperation
ICU	Extubation time, ICU stay
Hospital course	Hospital stay, wound complications
Functional outcomes	Pain, mobilization, quality of life
Technical safety	Conversion, graft flow, graft patency

Final Scientific Concept

The available evidence supports the following concept: minithoracotomy CABG is not a universal replacement for conventional sternotomy. It may be an effective alternative in selected patients, in experienced centers, when complete revascularization is preserved and perioperative management is well organized.

The most reliable advantages are early recovery, reduced surgical trauma, less bleeding, shorter ICU stay, and shorter hospitalization.

The aspects that remain insufficiently proven are reduction in mortality, reduction in stroke, reduction in perioperative myocardial infarction, and superiority in all multivessel coronary disease patients.

Conclusion

Coronary artery bypass grafting through minithoracotomy is a promising and patient-centered approach in the surgical treatment of ischemic heart disease. Current evidence suggests that this method may be safe in selected patients, reduce operative trauma, and accelerate early postoperative recovery.

At the same time, existing evidence does not prove that minithoracotomy CABG is universally superior to conventional sternotomy in all clinical settings. Its main advantage is not necessarily long-term mortality reduction, but improvement of the immediate postoperative course, faster recovery, and more efficient use of hospital resources.

Therefore, the key question in modern cardiac surgery should not be “which method is the best?”, but “which method is optimal for this patient?” Minithoracotomy CABG is scientifically and clinically justified only when evaluated together with patient selection, surgeon experience, institutional capability, and completeness of revascularization.

Practical Recommendations

1. Minithoracotomy CABG should be selected according to individual risk profile and coronary anatomy.
2. During implementation, it is reasonable to start with low- and intermediate-risk patients.
3. Completeness of revascularization should be considered more important than the benefit of a smaller incision.
4. Each center should monitor its own learning curve using objective statistics.
5. Future local studies should compare minithoracotomy and sternotomy groups.
6. Graft patency, quality of life, and pain syndrome should be studied as separate endpoints.

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