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First total coronary revascularization via left anterior thoracotomy – TCRAT in Slovenia

Prva popolna revaskularizacija miokarda skozi levo sprednjo torakotomijo v Sloveniji

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Abstract

Total coronary revascularization via left anterior thoracotomy presents a less invasive alternative to traditional coronary artery bypass grafting for complex coronary artery disease. It combines the benefits of minimally invasive surgery with a simplified approach, making it a promising option for surgical coronary artery disease management. In this report, we present the first case of a total coronary revascularization via left anterior thoracotomy performed in Slovenia, involving a 56-year-old patient with symptomatic two-vessel coronary artery disease.

Izvleček

Koronarna revaskularizacija skozi levo sprednjo torakotomijo je manj invazivna alternativna možnost tradicionalni revaskularizaciji koronarnih arterij pri kompleksni koronarni bolezni. Povezuje prednosti minimalno invazivne kirurgije s poenostavljenim pristopom in obeta učinkovit ter varen način kirurškega zdravljenja koronarne bolezni. Prispevek poroča o prvi popolni koronarni revaskularizaciji srca skozi levo sprednjo torakotomijo v Sloveniji, ki smo jo opravili pri 56-letnem bolniku z dvožilno koronarno boleznijo s simptomi.

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1 Introduction

Coronary artery bypass grafting (CABG) via sternotomy is widely considered the gold standard for myocardial revascularization in multivessel coronary artery disease (CAD) (1,2). However, the invasive nature of traditional CABG, particularly the full sternotomy approach, often leads to decreased physical functioning and potential complications, such as sternal dehiscence and deep sternal wound infection (3). The associated invasiveness, especially the physical debilitation and reduced quality of life resulting from full sternotomy, underscores the need for less traumatic alternatives. In 2019, a less invasive alternative, total coronary revascularization via left anterior thoracotomy (TCRAT), was proposed (4). Although minimally invasive techniques such as robotic endoscopic CABG or minimally invasive cardiac surgery (MICS) offer reduced invasiveness, their adoption remains limited due to procedural complexity and infrastructure requirements (5-7). The emergence of TCRAT over the last five years presents a promising alternative, allowing complete revascularization without midline sternotomy. Despite its growing adoption, cases of TCRAT in Slovenia have not been previously reported. We introduced this minimally invasive technique to our clinic, and we report our first experience with TCRAT performed on a 56-year-old patient.

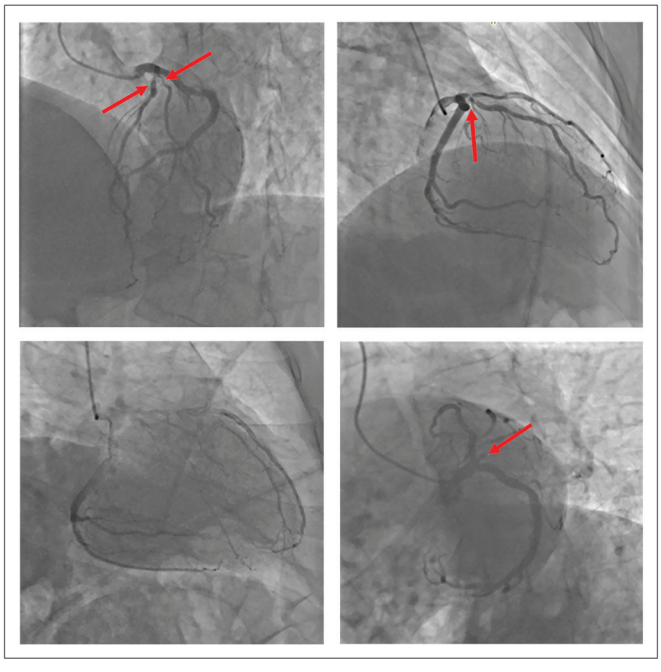

Figure 1: Preoperative coronary angiography showing the stenosis of left anterior descending (LAD), diagonal (D1) and chronic total occlusion (CTO) of ramus intermedius (rIM).
Source: archive of the Clinical Department of Cardiovascular Surgery, University Medical Centre Maribor.

2 Case presentation

A 56-year-old male with symptomatic CAD was admitted for expedited surgical coronary revascularization. Despite optimal medical management, including treatment for ischemic heart disease, a previous silent myocardial infarction, arterial hypertension, and hypercholesterolemia, the patient continued to experience angina symptoms necessitating surgical intervention. Preoperative assessment, including coronary angiography, revealed severe multivessel CAD, prompting the need for total coronary revascularization (Figure 1).

The TCRAT procedure has been thoroughly described in detail elsewhere (4). In summary, following a standard anesthesia protocol, right-sided single-lung ventilation was initiated using a bronchial blocker. Subsequently, a left-sided mini-thoracotomy incision was made through the fourth intercostal space (Figure 2A).

The left internal mammary artery (LIMA) was harvested through the left mini-thoracotomy using a ThoraGateTM rib-up retractor (Geister Medizintechnik, Tuttlingen, Germany) through the 4th intercostal space. A skeletonized technique was utilized using electrocautery and vascular clips. Concurrently, an assistant harvested a saphenous vein from the patient's left leg. Following appropriate heparinization, peripheral arterial and venous femoral cannulation was performed using transesophageal echography (TEE) guidance. The cannula for antegrade cardioplegia was placed in the ascending aorta. Subsequently, extracorporeal circulation was initiated. During this time, both the LIMA and vein were prepared. The ascending aorta was clamped with adequate perfusion using a Chitwood (Scanlan International Inc, St. Paul, MN, USA) clamp through a separate 1-cm incision in the left 2nd intercostal space. The heart was then arrested using cold blood antegrade cardioplegia, repeated approximately every 10 minutes. Then, three nylon tapes were placed around the aortic root (Ao), left pulmonary veins (PV), and inferior vena cava (IVC) (Figure 2B).

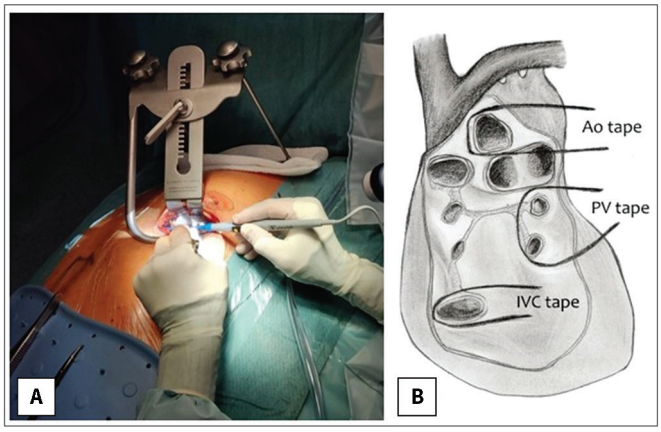

Figure 2: Chest opening for coronary revascularization through left anterior thoracotomy (A) and tapes for exposure of coronary vessels (B).
Source: archive of the Clinical Department of Cardiovascular Surgery, University Medical Centre Maribor.

The three target coronary arteries were exposed for distal anastomoses by manipulating the nylon tapes. First, the distal anastomosis on the ramus intermedius artery (rIM) was created, followed by a sequential anastomosis of LIMA to LAD and D1. After completion of the distal anastomoses, the aortic clamp was released, and a side clamp was placed on the ascending aorta. A spontaneous cardiac rhythm was restored. With the manipulation of the nylon tape and the side clamp, the ascending aorta was put in the optimal position for proximal anastomoses construction. One proximal venous anastomosis was constructed, one in the place of the antegrade cardioplegia catheter. After completion of the proximal anastomosis, the side clamp was released. All anastomoses were inspected, and the patient was gradually weaned off the extracorporeal circulation. Heparin was neutralized with protamine, and the patient was decannulated. Flow through the cardiac bypass grafts was verified using a transit time flow meter (Medistim, Oslo, Norway) probe. Hemostasis was meticulously achieved, and the chest opening was closed in layers, with a thoracic drain placed in the left pleural cavity. (Figure 3).

Figure 3: Postoperative incision on our 56-old male patient.
Source: archive of the Clinical Department of Cardiovascular Surgery, University Medical Centre Maribor.

3 Outcome

Postoperatively, the patient was transferred to the Cardiac Surgery Perioperative Intensive Care Unit for monitoring. Serial assessments, including hemodynamic monitoring, cardiac enzyme measurements, and echocardiography, revealed satisfactory recovery without evidence of myocardial ischemia, rhythm disturbances, or hemodynamic instability. Following successful extubating and stabilization, the patient was transferred to the ward. The postoperative course was uneventful, and the patient was discharged home on the fifth postoperative day.

4 Discussion

The case presented herein highlights the utilization of TCRAT as a less invasive alternative to standard CABG through median sternotomy.

Median sternotomy can lead to severe complications, including sternal wound infections, sternal dehiscence, and extended recovery periods. Studies have demonstrated that patients undergoing sternotomy experience significant reductions in health-related quality of life and functional capacity postoperatively (4). To mitigate these risks, minimally invasive sternum-sparing techniques have been developed and are now widely adopted in various fields of cardiac surgery, such as those involving the aortic and mitral valves, and treatments for atrial fibrillation. However, these advancements have not yet become prevalent in coronary revascularization surgery.

While CABG remains the gold standard for myocardial revascularization in multivessel CAD, the associated morbidity and impaired quality of life due to sternotomy incisions have driven the exploration of less invasive approaches, such as TCRAT (1).

The selection criteria for TCRAT involve a

combination of anatomical, clinical, and patient-specific factors. TCRAT is particularly suitable for patients with limited coronary disease, such as lesions in the LAD, D1, or rIM, where only a limited number of vessels need revascularization. However, in experienced hands, complex multivessel disease is not a contraindication for TCRAT. Additionally, TCRAT is beneficial for patients with comorbidities like obesity, diabetes, or chronic obstructive pulmonary disease, which elevates the risks of traditional sternotomy. Patients seeking a minimally invasive approach with faster recovery and smaller incisions are often ideal candidates. The procedure also requires that target coronary vessels are of adequate size and quality, and patients should be in stable health to tolerate the demands of the technique. Careful selection is crucial to ensure that TCRAT is the optimal choice for patients with coronary disease.

The benefits of TCRAT lie in its potential to mitigate the drawbacks associated with conventional CABG, primarily stemming from midline sternotomy. The introduction of TCRAT offers a promising solution to address these concerns by providing a less invasive surgical option. Existing literature on minimally invasive techniques, including robotic endoscopic CABG and hybrid procedures, has shown promising outcomes in terms of reduced invasiveness and improved patient recovery (5-7). However, these approaches have faced challenges in widespread adoption due to procedural complexity and infrastructure requirements, which are usually associated with high financial costs. TCRAT presents an alternative that combines the benefits of minimally invasive surgery with a simplified surgical approach, potentially overcoming some of the barriers to adoption encountered by other techniques.

While TCRAT offers significant advantages in select patient populations, it also has notable limitations in certain clinical scenarios. One key challenge arises in redo-procedures involving patients with prior sternotomy or chest surgeries. In these cases, fibrous adhesions of the pericardium can severely restrict heart mobility, significantly complicating the procedure.

Similarly, adhesions of the left pleura, often resulting from prior left lung surgeries, can make mammary grafting particularly difficult. Altered anatomy may further impede access to the mammary artery and coronary vessels via a left anterior thoracotomy, increasing the risk of injury to surrounding structures and reducing the efficacy of the approach.

Thoracic deformities, such as those associated with Marfan syndrome or severe scoliosis, can distort the rib cage and sternum, complicating surgical exposure. These conditions may also alter the positioning and mobility of the heart, further challenging the surgical field.

Although TCRAT is not contraindicated in patients requiring bilateral internal mammary artery grafts, it requires a specialized retractor to facilitate harvesting of the right internal mammary artery through the left anterior mini-thoracotomy.

Severe peripheral arterial disease can preclude peripheral cannulation. Similarly, extensive atherosclerotic involvement of the ascending aorta may complicate the procedure due to the increased manipulation of the aorta during surgery and the need for additional aortic side-clamping during proximal anastomosis construction. Furthermore, TCRAT is less suitable for emergency cases or unstable patients, where rapid initiation of cardiopulmonary bypass and immediate revascularization are critical and cannot tolerate delays.

These challenges emphasize the importance of thorough preoperative evaluation and tailored surgical planning to determine the most appropriate revascularization strategy for patients with complex anatomical or clinical conditions.

In the context of the presented case, the successful application of TCRAT in a 56-year-old male patient with symptomatic CAD demonstrates its feasibility and efficacy as an alternative to traditional sternotomy. Despite the patient's medical history, including previous myocardial infarction, TCRAT was performed without intraoperative complications, leading to excellent postoperative outcomes. This case adds to the growing body of evidence supporting the use of TCRAT in patients with CAD, particularly those who may be at a high risk of developing serious complications linked to median sternotomy.

Future studies and long-term follow-up are warranted to further evaluate the long-term safety, efficacy, and durability of TCRAT compared to traditional CABG and other minimally invasive techniques. Additionally, comparative studies assessing outcomes such as mortality, morbidity, and quality of life between different surgical approaches will provide valuable insights into the optimal management of patients with CAD.

In conclusion, the successful performance of TCRAT in this case underscores its potential as a minimally invasive alternative to traditional CABG in patients with CAD. However, while TCRAT represents a promising alternative to traditional median sternotomy for coronary revascularization, its applicability is not without limitations. Careful patient selection,

including consideration of anatomical factors, comorbidities, and the complexity of the coronary disease, is essential to ensure optimal outcomes. As the technique continues to evolve, further studies and long-term follow-up are necessary to refine its indications and assess its comparative effectiveness in various clinical scenarios.

5 Conclusion

Our experience with the first reported case of TCRAT in Slovenia demonstrates its feasibility and efficacy as an alternative to traditional sternotomy for total coronary revascularization in selected patients with complex CAD. This minimally invasive approach offers the potential for favorable postoperative outcomes and enhanced quality of life. Further studies are warranted to assess its long-term safety and effectiveness in a broader patient population.

Conflict of interest

None declared.

Informed consent of the patient

The patient gave informed consent for the publication of his case.

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