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Combination of endoscopic internal thoracic artery harvest and proximal anastomoses on the descending aorta in minimally invasive coronary artery bypass grafting

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SUMMARY

Minimally invasive coronary artery bypass grafting is less invasive. Proximal anastomoses at the ascending aorta, in contrast, are technically difficult to perform because of the limited field of view. A man in his 60s undergoing haemodialysis required minimally invasive coronary artery bypass grafting for left anterior descending artery and circumflex arterial restenosis. We successfully performed minimally invasive coronary artery bypass grafting with a proximal graft anastomosis of the descending aorta. A thoracotomy was performed to extend the lateral approach to the descending aorta. We performed a minithoracotomy using three-dimensional endoscopy for internal thoracic artery harvesting. Endoscopic internal thoracic artery harvesting minimises incision length. The combination of endoscopic and lateral thoracotomy incisions in minimally invasive coronary artery bypass grafting enabled small and lateral thoracotomy incisions.

BACKGROUND

Minimally invasive coronary artery bypass grafting (MICS CABG) is a coronary bypass graft surgery that is performed without a median sternotomy. MICS CABG surgery reduces several complications, including wound infection and length of stay in the hospital.[1] Although MICS CABG is less invasive, this technique has rarely been adopted as a surgical approach for patients with multivessel lesions, likely owing to the surgical challenges and difficulties inherent in this procedure. Proximal anastomoses at the ascending aorta and harvesting the internal thoracic artery (ITA) by direct vision are technically difficult in MICS CABG.[2 3] When used through the limited left posterior thoracotomy employed for lateral MICS CABG surgery, manipulation of the ascending aorta is difficult because of the poor visual field. A stepwise approach and several materials are necessary to perform proximal anastomoses directly off the ascending aorta safety.[4] A posterolateral thoracotomy incision provides excellent exposure to the lateral surface of the heart. Therefore, we chose the descending aorta to be used as a proximal source for lateral thoracotomy, which is safe and easy to approach. Pain is a major problem with this method because the incision must be extended laterally for anastomosis of the descending aorta. Previously, a minithoracotomy was performed using minimally invasive direct coronary artery bypass grafting (MIDCAB's) three-dimensional (3D) endoscopy.[5] The endoscopic ITA harvesting enables us to minimise the incision length and perform lateral thoracotomy. The combination of endoscopic ITA harvesting and small thoracotomy incision led to a reduction in the pain issue.

CASE PRESENTATION

The patient was a male in his 60s who underwent haemodialysis. He had a history of percutaneous coronary intervention (PCI) for the right coronary artery due to unstable angina. Preoperative angiography revealed 90% stenosis of the left anterior descending artery (LAD) and circumflex artery (Cx) including a left main lesion (LMT) (figure 1A). The cardiologist hesitated to perform PCI due to the complexity of the anatomy. The lesions were not suitable for PCI because the LMT lesion and LMT bifurcation angle were wide (figure 1B). Thus, for this reason, the patient was advised to undergo CABG. Since the patient required early recovery, we planned minimally invasive cardiac surgery.

INVESTIGATIONS

Preoperative chest-enhanced CT was necessary to decide the strategy of the proximal anastomoses. When atherosclerosis precluded anastomosis to the ascending or descending aorta, we also considered using subclavian artery as an alternative. Enhanced CT revealed calcification and debris around the aortic arch. In contrast, the level of the descending aorta under the pulmonary hilum was smooth. We determined the proximal anastomoses on the descending aorta and total endoscopic ITA harvesting (figure 1C).

TREATMENT

The patient was placed in the supine position with the left side raised at 30°. After the induction of anaesthesia, a double-lumen endotracheal tube for single-lung ventilation was used. A major incision was made in the fifth intercostal space lateral to the mid-axillary line. A 3D endoscope was inserted through the fifth intercostal space, and a 5 mm instrumental port was positioned in the fourth intercostal space (figure 2). We removed the left ITA (LITA) with the harmonic scalpel using the skeletonised technique. The entire length of the LITA was harvested with total endoscopic vision using 3D endoscopy (figure 3A). We harvested the

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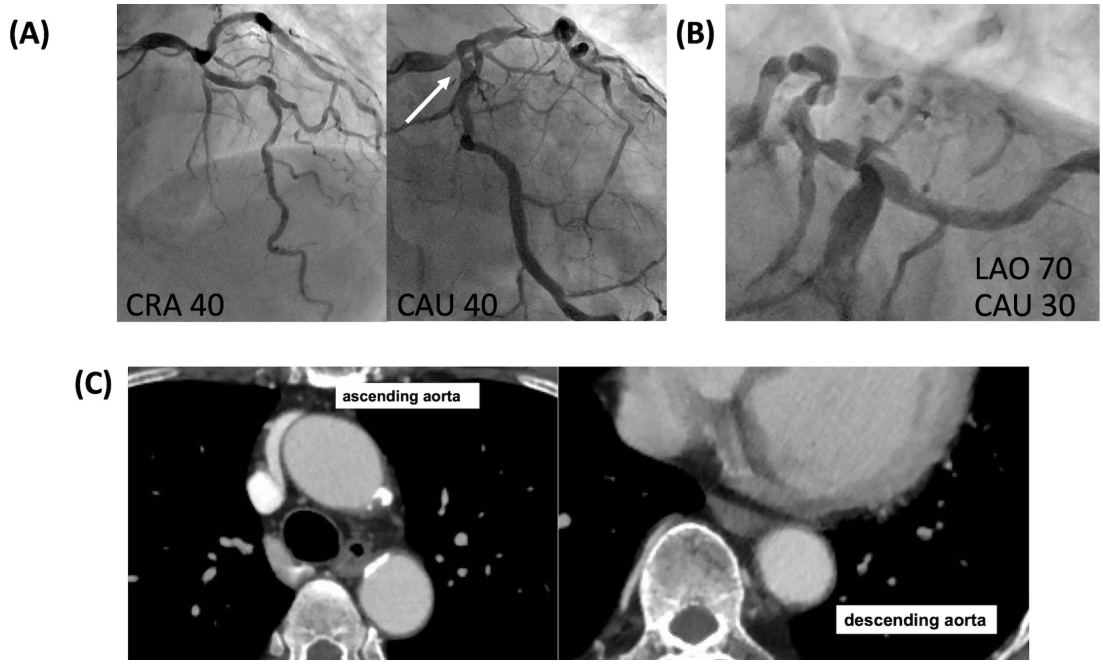

Figure 1 (A) Coronary angiogram showing stenosis of left anterior descending coronary artery and stenosis in LMT extending to left circumflex artery (white arrow) (B) coronary angiogram showing wide angle of LMT bifurcation. (C) Preoperative enhanced CT of the ascending and descending aorta. CAU, caudal; CRA, cranial; LAO, left anterior obliquee; LMT, left main coronary trunk.

saphenous vein for the Cx. Thereafter, the main incision was extended to the 10 mm camera port to gain additional exposure. The inferior pulmonary ligament of the left lung was released, and the deflated left lung was packed into the apex of the left pleural cavity. Heparin (10 000 U) was administered, and active clotting time was maintained for longer than 300 s. A side-biting clamp is placed in the descending aorta. Proximal vein graft anastomoses were completed by running 6-0 polypropylene under direct vision (figure 3B). The traction sutures were positioned on the pericardium to expose the lateral wall of the heart. The pericardium was then retracted using stay sutures. The pericardium was opened just anterior to the left phrenic nerve and the marginal branches of the Cx were identified. The vein graft is routed beneath the pulmonary hilum. Distal anastomoses to the Cx with 8-0 polypropylene were performed using a stabiliser. The LITA-LAD anastomoses were then performed using a continuous 8-0 polypropylene suture. At the end of surgery, protamine was administered to fully reverse the effect of heparin. The chest tube was positioned at a distance from the bypass graft. The mean operative time was 248 min.

OUTCOME AND FOLLOW-UP

The patient had an uneventful postoperative course and was discharged on postoperative day 7. He was energetic during his follow-up visit 6 months after discharge. Enhanced CT at

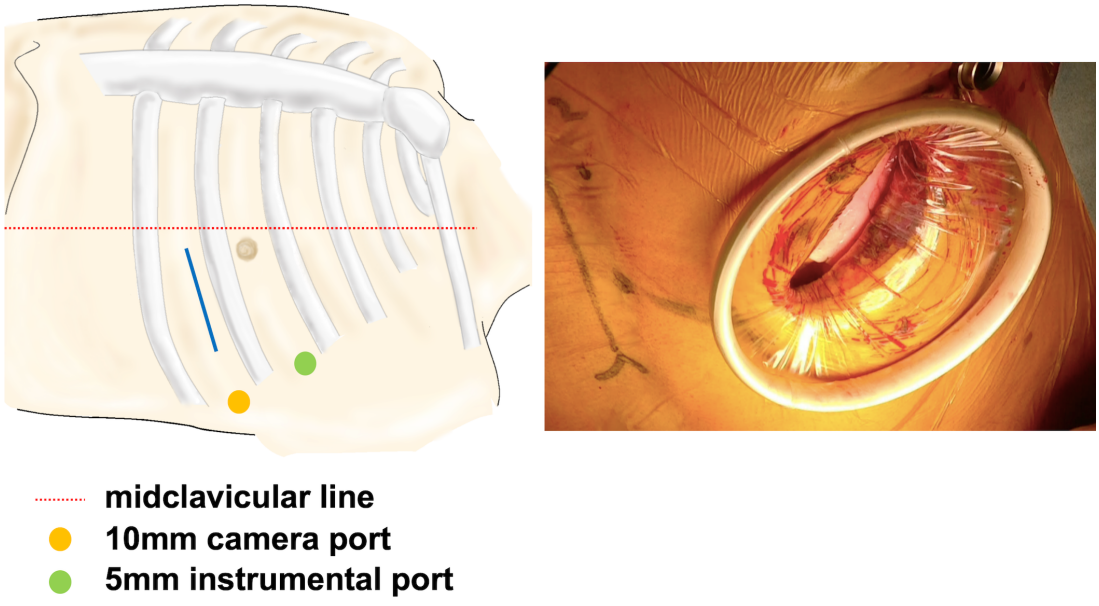

Figure 2 Diagram of the surgical incision and port access position.

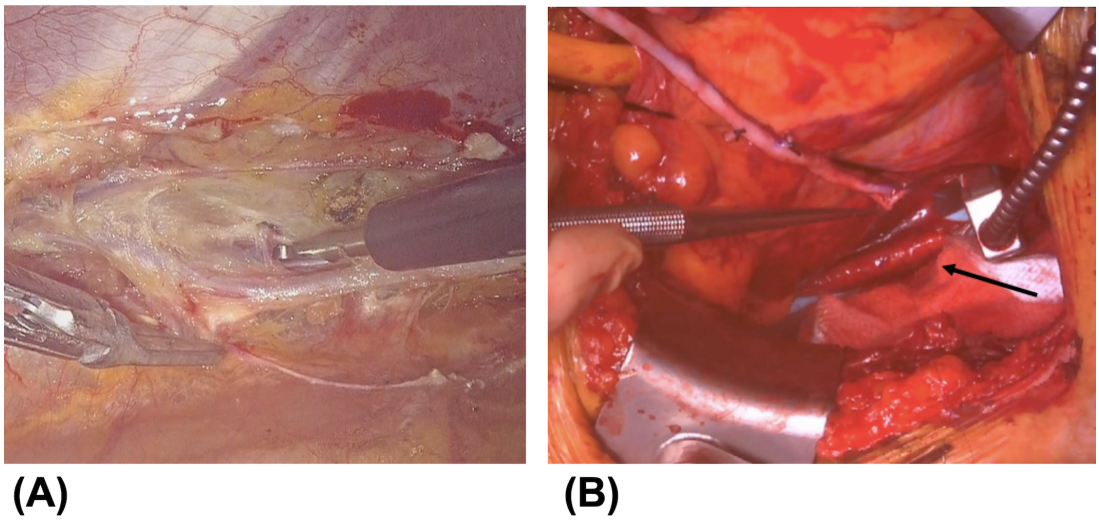

Figure 3 (A) Total endoscopic ITA harvesting. (B) Proximal anastomosis onto the descending aorta through the left small thoracotomy. Black arrow indicates the descending aorta. ITA, internal thoracic artery.

6 months revealed that all graft was patent (figure 4). The patient gave written informed consent for the publishing of his case.

DISCUSSION

MICS CABG involves CABG via a small anterolateral thoracotomy. Lapierre *et al* noted excellent MICS CABG procedural outcomes and freedom from complications, including revascularisation, major morbidity and wound infection.[1] Nevertheless, it was difficult for MICS CABG to gain good exposure of the vessel to be grafted, which proved difficult or associated with haemodynamic instability, especially in the posterolateral circumflex branch, during positioning of the heart. A greater rate of cardiopulmonary bypass was noted in MICS CABG.[1] From the experience of the 450 cases of MICS CABG, McGinn *et al*[6] reported that the approach of incising to the left side of the midclavicular line is anatomically superior and highly safe for the approach to the left coronary artery region. More lateral thoracotomy allows for rib spreading with less risk of rib injury and for the use of the space normally occupied by the left lung to work within the chest. A lateral thoracotomy incision provides excellent exposure of the lateral surface of the heart. On the major issue, the ascending aorta is difficult to access from the left side. Aortic bleeding complications are difficult to manage in lateral thoracotomy. Although Vincent reported that handsewn proximal anastomoses onto the ascending aorta were enabled through a small left thoracotomy, several setups were necessary to perform safely.[4] In addition, manipulation of the ascending aorta is an independent risk factor for postoperative stroke.[7]

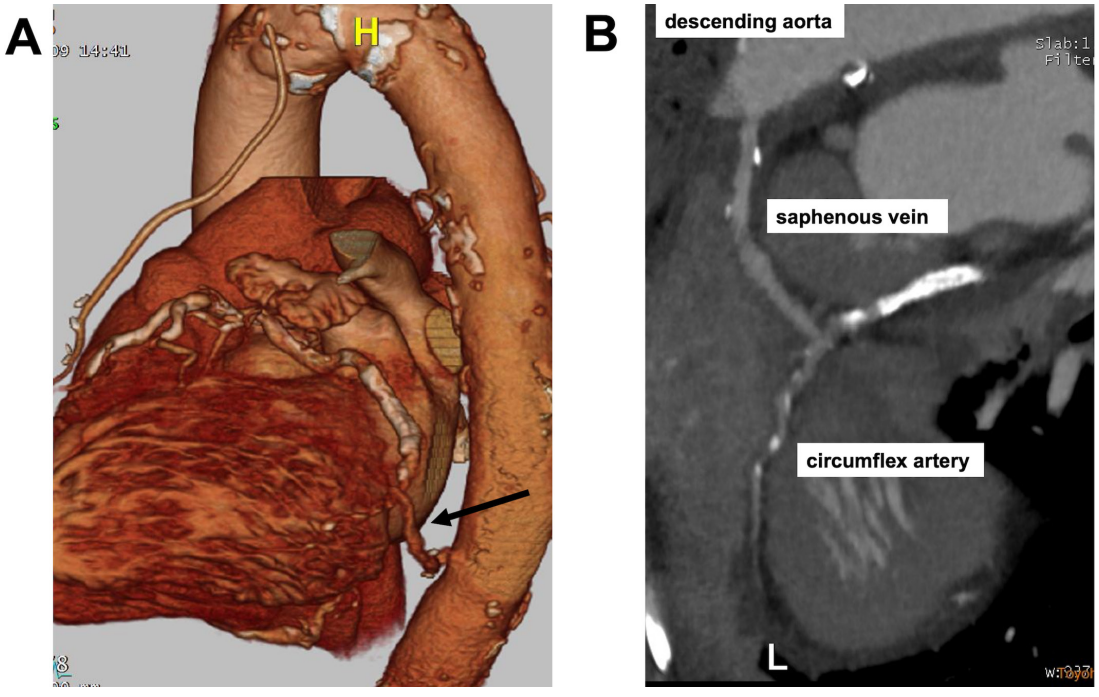

Figure 4 (A) An enhanced CT scan performed 6 months after surgery revealing a patent graft. Black arrow: saphenous vein graft. (B) Curved-multiplanar reconstruction image demonstrates the patent graft at the descending aorta.

Because of these characteristics, we considered that manipulation of the ascending aorta was inappropriate in MICS CABG. Therefore, we decided to perform proximal anastomoses on the descending aorta.

Enhanced CT is necessary to determine where to put the proximal anastomoses. We evaluated the aortic wall condition whether calcification and debris were present. In this case, there were calcification around the ascending aorta; whereas, the descending aorta had smooth wall. So, we determined the proximal anastomoses on the descending aorta. The lateral thoracotomy with the anastomoses onto the descending aorta for circumflex coronary disease was reported for both primary and reoperative revascularisation.[8] Lateral thoracotomy approach was safely performed in 34 patients with isolated coronary artery disease of the circumflex system with lower early and late morbidities.[9] However, there are few reports of this technique for MICS CABG with multivessel. We believe that the reason for hesitation of anastomosis at the descending aorta in MICS CABG is that it requires an extended large incision, especially in the case of ITA harvesting with direct vision. To access the descending aorta, extension of the incision to the lateral side is necessary. In ITA harvesting using direct vision, the incision is centred over the mid-clavicular line.[2] Pain and cosmetics are major issues due to the increasing incision length. We previously reported a technique for total endoscopic ITA harvesting using 3D endoscopy without a robotic system.[5] The 3D endoscope has an enhanced ability for image analysis and enables a more reliable visualisation of the branches of the ITA than direct vision. 3D endoscopy offers the advantage of a lower running cost than robotic systems.[2] Thoracoscopic ITA takedown can minimise incision length and locate the thoracotomy laterally. Endoscopic ITA harvesting compensates for the disadvantages of large lateral thoracotomy.

Apart from MICS CABG, a hybrid treatment combining PCI and minimally invasive direct CABG is an emerging alternative in coronary artery treatment. However, PCI has reported poor results in treating LMT complex lesions of coronary arteries.[10] Therefore, in this case, we decided that MICS CABG was the appropriate treatment due to the complexity of the coronary lesion. We confirmed the graft patency and uneventful course at 6 months follow-up. Fonger *et al* reported that the free graft was routed inferior to the hilum of lung to prevent kinking when the lung is re-expanded to its native position.[8] One of the reasons for the better result may be due to following that strategy. Although further experience and long turn outcome will serve to define the ultimate capabilities of this approach, this result suggests that the technique is effective in MICS CABG, especially in the case of unavailability of the ascending aorta.

Patient's perspective

I appreciate the doctor for the minimally invasive treatment and giving me strong hope. After surgery, I was advised to follow-up every 6 months. Currently, I am living comfortably without any symptoms.

Learning points

- Lateral thoracotomy is an ideal approach for minimally invasive coronary artery bypass grafting owing to its excellent exposure of the lateral surface of the heart.
- Proximal anastomoses onto the descending aorta is a suitable technique anatomically, and enables to avoid embolic stroke.
- Total endoscopic internal thoracic artery harvesting can minimise incision length and locate the thoracotomy laterally.

In conclusion, endoscopic ITA harvesting is a useful technique when performing proximal anastomosis of the descending aorta, which requires lateral thoracotomy.

Contributors YG wrote the manuscript. YG and ST treated patient and performed the operation. YG, AN, JY and ST performed the followed-up of the patient. YG and ST performed total organisation of writing the manuscript. all authors read and approved the final manuscript.

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