Case report - Coronary
A novel internal thoracic artery harvesting technique via subxiphoid approach – for the least invasive coronary artery bypass grafting

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Abstract
We have performed 12 cases of robotically assisted coronary artery bypass grafting (CABG) to accomplish less invasive revascularization. In this report, we describe a new method of robotically assisted internal thoracic artery (ITA) harvesting via subxiphoid approach, using the da Vinci surgical system. A 22-year-old man with three-vessel coronary artery disease due to Kawasaki disease was referred to our institution for coronary artery revascularization. A small subxiphoid incision was made, and the xiphoid process at the lower end of the sternum was excised. A U-shaped hook was inserted into the retrosternal space, and the lower sternum was lifted. A 30° angle-up camera was inserted under the U-shaped hook, bilateral ITAs were harvested in a totally skeletonized fashion endoscopically. The required time for right ITA harvesting was 50 min, and that for the left was 20 min. After bilateral ITAs were harvested, composite grafts were made, and then the distal anastomoses were made. The patient was discharged six days after the operation. We performed a new robotically assisted bilateral ITA harvesting technique via subxiphoid safely and with excellent results. This method might be an evolutionary step of minimally invasive direct coronary artery bypass (MIDCAB) using the da Vinci surgical system.

Keywords: Robot; da Vinci surgical system; Internal thoracic artery; Subxiphoid approach

1. Introduction
The ultimate goal of minimally invasive direct coronary artery bypass (MIDCAB) is multivessel revascularization with same-day hospital discharge. Robotic surgical technology helps minimize invasiveness to the surgical site, and enables harvesting the entire length of bilateral internal thoracic arteries (ITAs) without thoracotomy or median sternotomy [1–3]. This time, in an attempt of the least invasive surgery, we adopted a new method of robotically assisted bilateral harvesting ITAs via a subxiphoid approach.

2. Case report
A 22-year-old man with three-vessel coronary artery disease due to Kawasaki disease was referred to our institution for coronary artery revascularization. Cardiac catheterization revealed severe stenosis of the proximal left anterior descending coronary artery (LAD), left circumflex artery (LCX), total occlusion of the proximal right coronary artery (RCA). The left ventricular ejection fraction was 62%. We obtained written informed consent from the patient, after thoroughly explaining the details of the novel ITA harvesting technique via a subxiphoid approach using the da Vinci surgical system (Intuitive Surgical, Inc, Mountain View, CA, USA) and its advantages. This technique might provide more stable ventilation while ITAs are harvested. Then robotically assisted MIDCAB was planned to allow the patient an earlier recovery.

After the induction of general anesthesia, a double-lumen endotracheal tube was introduced to permit selective ventilation, and the patient was placed in a supine position. First, the left radial artery (RA) was harvested. Simultaneously, a 5-cm-long subxiphoid incision was made, and the xiphoid process at the lower end of the sternum was excised. After that, the retrosternal premediastinal space was dissected, and a U-shaped hook was inserted to elevate the sternum. Two 1-cm-long skin incisions were made symmetrically on both sides of the subxiphoid incision, and the instrument ports were inserted (Fig. 1). A 30° upward angle camera was inserted under the U-shaped hook. The two robotic arms were inserted over the right shoulder of the patient. CO₂ insufflation was used to create a premediastinal working space. After all these preparations, the right ITA was harvested in a totally skeletonized fashion with an EndoWrist spatula cautery (Intuitive Surgical) on one robotic arm and the EndoWrist deBakey forceps (Intuitive Surgical) on the other robotic arm. The small branches were coagulated or clipped endoscopically. Second left ITA was harvested in a similar fashion. The required time for right ITA harvesting was 50 min, and that for the left ITA was 20 min.

A 15-cm-long left anterior thoracotomy was then made in the fourth ICS. An end-to-side anastomosis was established between the left ITA and the 12-cm-long of RA so that a...
composite Y graft was made. An end-to-end anastomosis was established between the right ITA and the 6-cm-long RA so that a composite I graft was made. The left ITA was anastomosed to the LAD, and the composite Y graft was anastomosed to the LCX (obtuse marginal artery) via left anterior thoracotomy. Finally, the composite I graft was anastomosed to the RCA (#4 posterior descending artery) via subxiphoid incision. All distal anastomoses were hand sewn under direct vision, without cardiopulmonary bypass.

The total operative time was 375 min, and no blood products were required. The patient was discharged six days after the operation, and has been free of symptoms (Fig. 2). Postoperative coronary angiography showed that all grafts were patent.

3. Comment

The da Vinci surgical system provides a high-resolution stereoscopic image and allows remote, tremor-free, and scaled control of endoscopic surgical instruments with seven degrees of freedom. Robotically assisted CABG minimizes the access trauma and the current report confirms the viability and safety of this procedure [4]. Since 2006, we performed robotically assisted MIDCAB in 12 cases. In patients with multivessel coronary artery disease, it is most essential to secure sufficient blood flow in this kind of last access surgery. We used bilateral ITAs and composite grafts for complete revascularization. So far, we have harvested bilateral ITAs through thoracic approach as an in-situ graft. However, in this approach, one lung must be collapsed when bilateral ITAs are harvested from the left side. The important point of this technique is the specially designed U-shaped sternum retractor, which enables pulling the lower sternum upward, and subsequently the sternum itself, thus a sufficient operation field can be secured through a small subxiphoid skin incision. The scope was inserted through the center of the subxiphoid site, to reach the inner premediastinal space. From the operator’s view on the console, bilateral ITAs were observed parallel and linear, therefore both ITAs appear like parallel strips of fluorescence on the long, straight funnel from a driver’s view. This view enables the operator to find the small branches more easily than the thoracic approach, so they are quickly cauterized or clipped. Since this method does not need thoracotomy during bilateral ITAs harvesting, single lung ventilation is not mandatory, thus the patient’s respiration was stable. The avoidance of thoracotomy diminishes pleural adhesions, which has advantages in the next thoracic surgery. The avoidance of sternotomy has enabled less invasive multivessel MIDCAB. We are presently developing devices to enable further elevation of the lower sternum and costal margin, and if these can be made it would then be possible to perform all distal anastomoses through the subxiphoid approach, all procedures of MIDCAB including harvesting ITAs and distal anastomoses could be accomplished via a subxiphoid approach only. Watanabe et al. reported the feasibility of multivessel MIDCAB via the subxiphoid approach [5]. In the near future, awake robotically assisted MIDCAB may be possible without general anesthesia, and I think that the ultimate goal of the least invasive CABG is day surgery of robotically assisted multivessel MIDCAB.

In conclusion, we performed a new method of robotically assisted bilateral ITAs harvesting via subxiphoid approach safely with excellent results. This method appears to be an evolutionary step of robotically assisted MIDCAB using the da Vinci surgical system.

References