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Original

Three-dimensional Thoracoscopic Resection of a Left Ventricular Papillary Fibroelastoma

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SUMMARY

A papillary fibroelastoma at the apex of the left ventricle is benign and rare. Over the last two decades, minimally invasive cardiac surgery has been developed to be used under either direct vision via a small skin incision or endoscopic vision with or without robotic assistance via a very small skin incision. We report a case of three-dimensional thoracoscopic resection. A 68-year-old female with hypertension and paroxysmal atrial fibrillation had a growing mass in the left ventricular. An echocardiogram demonstrated a smooth and mobile mass with a diameter of 15 mm at the apex of the left ventricle. An enhanced magnetic resonance imaging revealed a cardiac tumor. Since she had suffered from diffuse mild cerebral infarctions, we performed three-dimensional thoracoscopic resection of the tumor which revealed to be left ventricular papillary fibroelastoma on histological examination. Her postoperative course went well without any complications. Using only three-dimensional thoracoscopy, we performed the cardiac surgery easily and shortened the operative time, including the preparation time, resulting in a satisfactory cosmetic result.

Keywords : minimally invasive cardiac surgery, totally thoracoscopic surgery, left ventricular papillary fibroelastoma

INTRODUCTION

Minimally invasive cardiac surgery has been used extensively over the last decade. Because of the development of new surgical instruments, we can perform cardiac surgery with a very small incision. Some institutions have started robotic-assisted cardiac surgery and have been able to perform less invasive complex cardiac surgery, such as mitral valve reconstruction ; however, the establishment of a robotic system requires a substantial cost and a large operating room to accommodate the instrumental cart[1)]. On the other hand, endoscopic cardiac surgery without robotic assistance was introduced two decades ago[2)]. Using conventional endoscopic instruments tends to be difficult, especially two-dimensional endoscopy, but three-dimensional thoracoscopy has been developed. This technology provides an excellent view for surgeons that allows in-depth perception and therefore easier surgery compared with two-dimensional thoracoscopy. We present a case of resection of a left ventricular papillary fibroelastoma (LVPFE) using only three-dimensional thoracoscopy.

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CASE PRESENTATION

A 68-year-old female with hypertension and paroxysmal atrial fibrillation was referred to our hospital

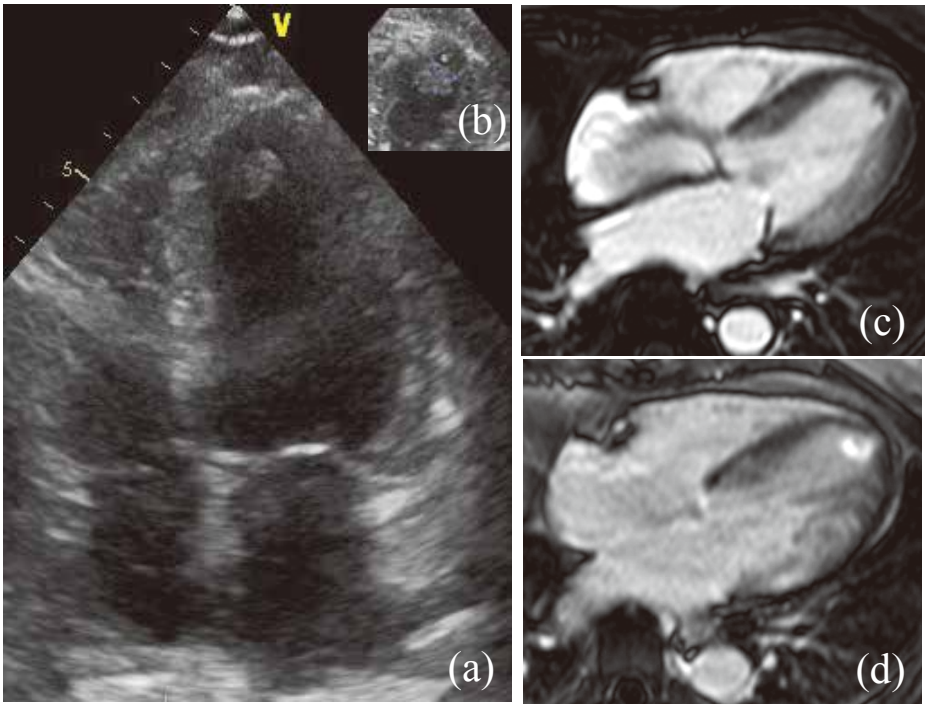

Fig. 1 Preoperative echocardiography and enhanced MRI findings
Echocardiography through the four-chamber view showed that the mobile cardiac tumor was attached to left ventricle at the apex (**a**). Focusing on the apex (**b**), the tumor had a diameter of 1.5×1.5 cm. Enhanced MRI revealed that the tumor had high intensity in delayed phase (**c**：early phase, **d**：delayed phase).

for a growing mass in the left ventricle. When she was hospitalized for pneumonia ten years ago, an echocardiogram incidentally showed a thrombus in the left ventricle. She had been anticoagulated since then. However, the mass, which was thought to be a thrombus had enlarged, and her interleukin-6 level was elevated (5.6 pg/mL). An echocardiogram in our hospital demonstrated a smooth and mobile mass with a diameter of 15 mm at the apex of the left ventricle. Magnetic resonance imaging (MRI) revealed a left ventricular tumor which showed high intensity on T2-weighted images and delayed enhancement on post-gadolinium sequence imaging (Fig. 1). In addition, a brain MRI revealed that she had suffered from diffuse mild cerebral infarctions. Although she did not have any symptoms of cerebral infarction, the tumor resection was required to prevent embolization of other organs. We planned three-dimensional thoracoscopic resection of the left ventricular cardiac tumor, as we had experienced several cases before, because a conventional full sternotomy was thought to be too invasive. The patient was intubated with a double-lumen endotracheal tube for selective right lung ventilation. Monitoring lines included arterial pressure lines and central venous access. Core body temperature was monitored via the bladder. The patient was placed in the supine position and 30 degrees to the left. Her right arm was dropped slightly to extend the intercostal space. Our three-dimensional thoracoscopic surgery was based on a previously reported method[3]. At first, a 12-mm camera port was inserted in the fourth intercostal space on the anterior axillary line. Then, a 5-cm main working window was created in the fourth intercostal space toward the medial side of the camera port through a 4-cm incision, and a secondary 3-cm working window was also created in the third intercostal space. The right groin was cut down, and the right common femoral artery and vein were exposed for cardiopulmonary bypass (CPB). The two working windows were covered with wound protractors (Alexis size XS and XXS, Applied Medical, Rancho Santa Margarita, CA, US). After heparinization, a

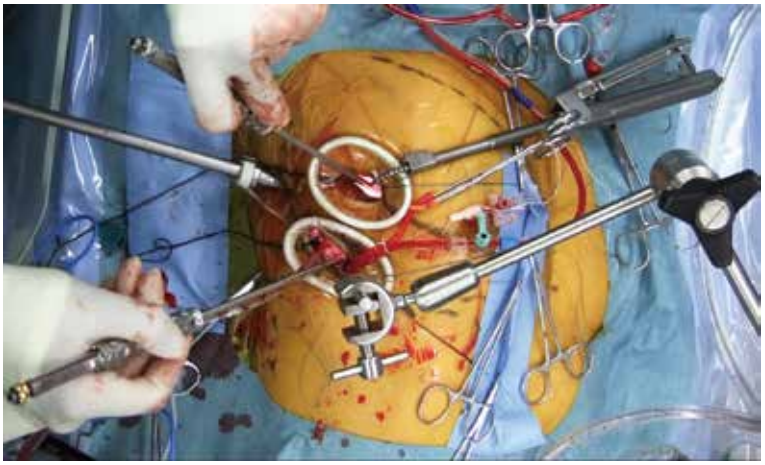

Fig. 2 Surgical setting
Overview of the surgical setting that shows two surgical windows and a camera port.

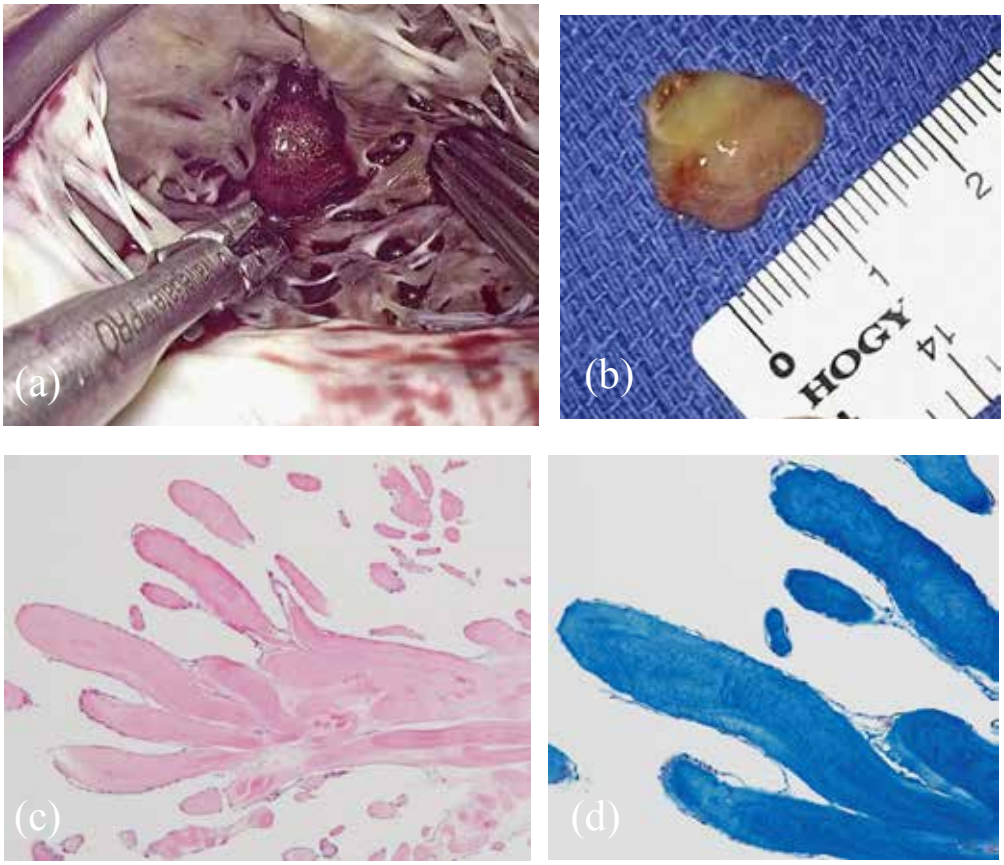

Fig. 3 Intraoperative viewing using three-dimensional thoracoscopy and the resected cardiac tumor including histological examination.
Close-up view of the left ventricle through the mitral valve showed that the tumor located between the anterolateral and posteromedial papillary muscles (**a**). The resected tumor had a diameter of 15 mm and was soft and smooth (**b**). Histological examination showed that the mass had avascular papillary fronds lined by endothelial cell (**c** : H&E stain) and contained collagen fibers (**d** : M&T stain).

16-F arterial cannula and 22-F venous cannula (QuickDraw, Edwards Lifesciences, Irvine, CA, US) were inserted, and CPB was established in the standard manner. Core body temperature was cooled to 32℃. We used a three-dimensional thoracoscopy system (IMAGE1S™, Karl Storz, Tuttling, Germany). When the intrathoracic space was entered, the pericardium was opened without damaging the right phrenic nerve and retracted using a guiding suture from an ENDO CLOSE device (Medtronic, Minneapolis, MN, US) that was inserted through the stab wound. The ascending aorta was cross clamped by Cygnet Flexible Clamp (Vitalitec, Plymouth, MA, US) through the secondary window. Antegrade cold blood cardioplegia was administered by a long cannula (JMS, Hiroshima, Japan) through the main window every 20-25 minutes (Fig. 2). When cardiac arrest was achieved, the left atrium was opened along the interatrial groove. After suturing on the roof and bottom of the left atrium, a left atrial retractor (MERA, Tokyo, Japan) was used to retract the anterior mitral leaflet. We confirmed that the tumor was at the left ventricular apex between the papillary muscles. We resected a 1.5×1.5 cm tumor, which was revealed as LVPFE on histological examination (Fig. 3). Finally, the left atrium was closed using a 4-0 monofilament running suture after de-airing, and the left atrial appendage was closed with an AtrialClip PRO (AtriCure, Mason, OH, US). The cross clamp and CPB time were 63 and 132 minutes, respectively. Her postoperative course went well without any complications or complaints of a chest pain, and she stayed at our hospital for 7 days until discharge. We found no residual tumor on a follow-up echocardiography.

DISCUSSION

Recently, several reports have demonstrated good results using robotic cardiac surgery, such as mitral valve repair[4], coronary artery bypass grafting[5] and extirpation of cardiac tumors[6]. Robotic surgery can duplicate the complex movements of a surgeon's arms. However, a robotic system is not available in every institution, because it is expensive and requires a large operating room. On the other hand, only thoracoscopic cardiac procedures have been performed with simple cardiac surgery, and they have been used for complex mitral repair procedures[3,7]. This method requires conventional minimally invasive cardiac surgery (MICS) instruments and thoracoscopy. Since complete video-assisted thoracic surgery (VATS) is often performed in thoracic surgery, intraoperative management would be easy for anesthesiologists and scrub nurses, and there would be no additional effort or cost to perform a thoracoscopic cardiac procedure without robotic assistance.

Cardiac tumors are rare, accounting for only 0.001-0.03% of primary tumors. Almost 90% of them are benign, and the majority are myxomas. Other benign primary cardiac tumors include papillary fibroelastomas, fibromas and lipomas. Cardiac tumors occur most frequently in the atriums and rarely in the ventricles (3-4% on either side)[8,9]. Although they are rare, there are some reports of resection of left ventricular tumors. Tarcon et al.[1] reported that they performed thoracoscopic resection of a left ventricular myxoma attached to the ventricular side of the anterior leaflet of the mitral valve using the Heart Port Endoclamp System and conventional thoracoscopic instruments. However, unlike their case, the cardiac tumor was at the apex of the left ventricle in our case. Therefore, we had to consider whether the tumor could be removed through the mitral valve via a left atriotomy because the tumor was some distance away from the mitral valve. If the tumor had not been visible with this approach, we would have switched to a median sternotomy and made an incision at the anterior left ventricle to remove the tumor. However, we decided to perform only thoracoscopic surgery, and we obtained sufficient visualization to remove the tumor using the left atrial retractor. We used a similar approach that was used by Suzuki et al.[10], who removed a left ventricular thrombus under thoracoscopic support. We used three-dimensional thoracoscopy and it has an excellent view that has in-depth perception and facilitates easier surgery compared with two-dimensional thoracoscopy. It was possible to perform complete resection without residual tumor and shorten the operative time.

In conclusion, we suggest that three-dimensional thoracoscopic cardiac surgery should be the first-line therapy for simple procedures, such as the resection of cardiac tumors, even if they are in the left cardiac

ventricle. If the patient does not have any severe respiratory disorders that prevent selective right lung ventilation, robotic assistance is not required.

List of abbreviations

LVPFE : left ventricular papillary fibroelastoma ; MRI : Magnetic resonance imaging ; CPB : cardiopulmonary bypass ; MICS : minimally invasive cardiac surgery ; VATS : video-assisted thoracic surgery

Ethics approval and consent to participate

Informed consent was obtained from the patient

Consent for publication

Written informed consent for publication of this case report was obtained from the patient

Availability of data and materials

All data generated during this study are included in this published article

Competing interests

The authors declare that they have no competing interests

Author's Contributions

Study conception : TY
Data collection : TY
Investigation : TY
Writing : TY, HY
Critical review and revision : all authors
Final approval of the article : all authors
Accountability of all aspects of the work : all authors

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