

# Hybrid robotic-assisted and minithoracotomy for pulmonary arterioplasty using autologous pulmonary vein graft



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The patient provided written informed consent.

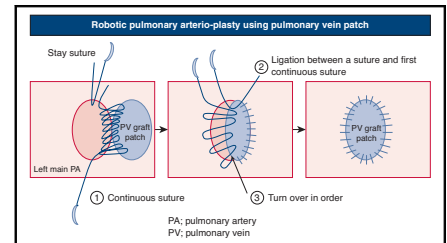
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**Robotic pulmonary arterioplasty using an autologous PV graft.**

## CENTRAL MESSAGE

Hybrid robotic surgery with pulmonary arterioplasty using an autologous PV graft with minithoracotomy is a safe and efficient approach to treat patients with locally advanced lung cancer.

Video clip is available online.

Pulmonary arterioplasty is used as an alternative to pneumonectomy to treat patients with centrally located tumors while preserving pulmonary function. There are few reports on robotic surgery combined with resection of involved tissues.<sup>1</sup> However, robotic surgery for arterioplasty has not been established. Robotic arterioplasty for treating patients with locally advanced lung cancer is technically challenging. We report a case of extended robotic surgery with arterioplasty using a pulmonary vein (PV) patch and our hybrid technique with a minithoracotomy.

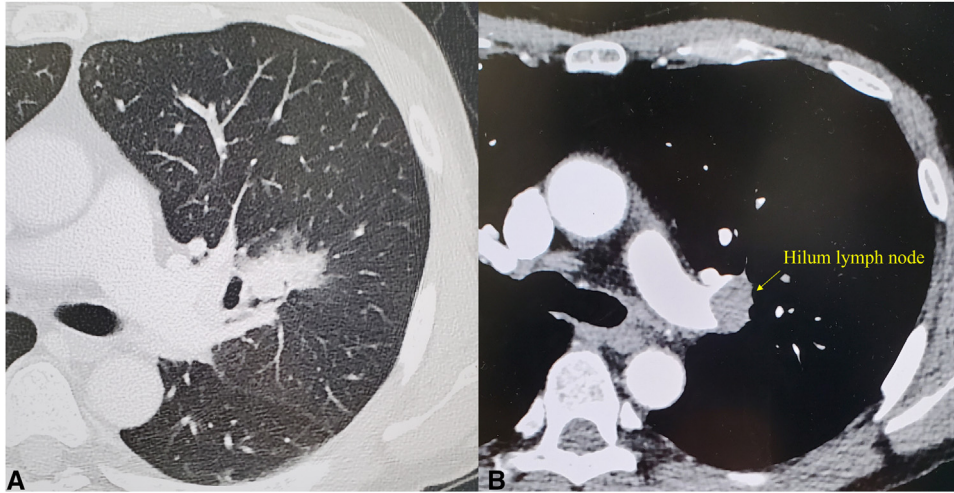
## CASE PRESENTATION

A 58-year-old man presented with a solid mass in the left upper lobe on computed tomography (Figure 1, A). The hilar lymph node directly invaded the left pulmonary artery (PA) (Figure 1, B). Positron emission tomography scan revealed a high standard uptake value for the main tumor and hilar lymph nodes without distant metastases. Brain magnetic resonance imaging showed no metastasis. The patient was clinically diagnosed with primary lung cancer (cT1cN1M0, stage IIB) according to the eighth edition of

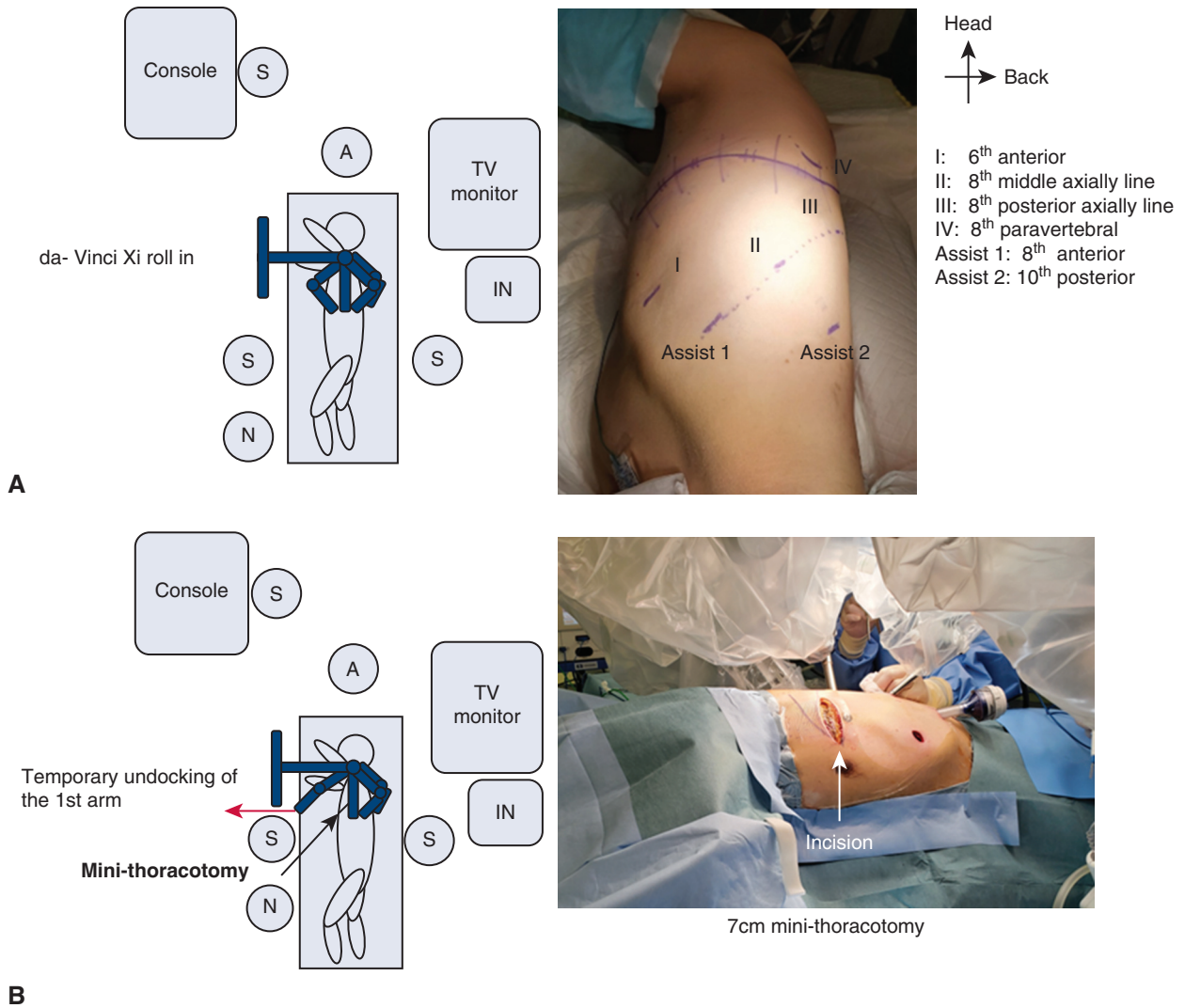
the Lung Cancer Classification. The study was approved by the ethics committee of Juntendo University (E23-0012, March 31, 2023). Written informed consent was obtained from the patient for the publication of this case.

## Surgical Technique

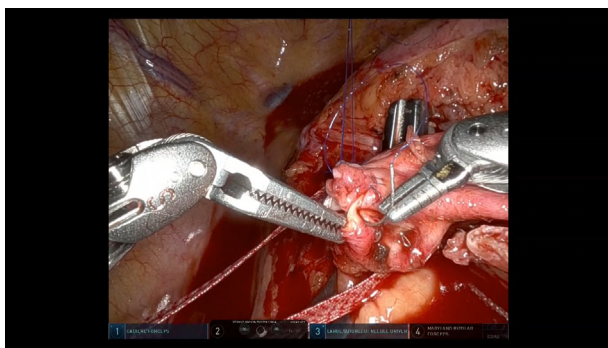
After the induction of general anesthesia using a double-lumen endotracheal tube and epidural anesthesia, the patient was placed in the left lateral decubitus position with his right arm raised. A 4-arm robotic approach using the da Vinci Xi system (Intuitive Surgical) was used for surgery. Three 8-mm intercostal robotic ports were placed in the eighth intercostal space, and one 12-mm port was placed in the sixth anterior intercostal space. An 8-mm zero-degree 3-dimensional robotic endoscope was used. Two assistant ports were placed at the eighth intercostal space on the anteroaxillary line and at the 10th intercostal space in the posteroaxillary space (Figure 2, A). The robotic instruments included spatula forceps (right arm), cadiere forceps (left arm), and fenestrated bipolar forceps (retracting arm). Robotic surgery was performed using carbon dioxide insufflation at 5 mm Hg.



**FIGURE 1.** A, Computed tomography of the chest showing a solid mass in the *left upper lobe*. B, Metastatic hilum lymph node directly invading the *left PA*.



**FIGURE 2.** A, Port placement and schema of the robotic approach. B, Intraoperative findings of the minimal anteroaxial thoracotomy approach and the positions of assistant surgeons. S, Surgeon; A, anesthesiologist; IN, instrument; N, nurse.



**VIDEO 1.** Operative video of hybrid robotic-assisted and minithoracotomy for pulmonary arterioplasty using autologous PV graft. Video available at: [https://www.jtcvs.org/article/S2666-2507\(23\)00194-3/fulltext](https://www.jtcvs.org/article/S2666-2507(23)00194-3/fulltext).

After hilar vessel dissection, a small incision was made on the anteroaxial side to clamp the left main PA (Figure 2, B). The central and peripheral sides of the PA were clamped using the minithoracotomy and robotic approaches, respectively. After removing the left upper lobe, arterioplasty was performed using a PV patch. A robotic large-needle driver was used for anastomosis. A continuous suture technique using 6-0 prolene (Ethicon Inc) was applied from the right side of the PV patch to the left. After saline containing heparin was injected into the PA, it was declamped (Video 1). The operative time was 287 minutes, with a blood loss of 15 mL. No intraoperative complications occurred, and intravenous heparin was not administered. The patient was discharged on the postoperative day 8. No postoperative complications, including anastomotic trouble, occurred.

## DISCUSSION

Reconstruction of the PA is useful for preserving pulmonary function while avoiding pneumonectomy. The benefits of a minimally invasive approach in patients with extended pulmonary resection include reducing postoperative pain and complications, shorter hospital stay, and earlier intervention with adjuvant treatment.<sup>2</sup> Recently, hybrid robotic approaches have been reported.<sup>1</sup> However, robotic reconstruction of the PA has not been described. In the case presented, a minithoracotomy approach was required for 2

reasons. First, the main PA was clamped safely because the hilar lymph node directly invaded the central side of the PA. Second, the PV graft was harvested for arterioplasty after the serous pericardium was opened using a minithoracotomy approach. Reconstruction materials include autologous PV and pericardium (porcine or bovine).<sup>3</sup> The PV graft was first reported by Cerezo and colleagues.<sup>4</sup> The PV wall is a distinctive autologous tissue with favorable thickness, resistance, and solid consistency with minimal risk of infection and thrombosis of the synthetic prosthesis.<sup>4,5</sup> Autologous materials without intravenous heparin is preferred for PA reconstruction. If the PV can be sufficiently harvested, an autologous PV graft is the first choice for PA reconstruction, and the second choice is autologous pericardium. Continuous sutures are required for anastomosis using nonabsorbable monofilaments. Robotic surgery can be performed with precise suturing movement by the free angle of needle insertion and clean anastomosis without open thoracotomy invasiveness. However, the da Vinci system does not provide force feedback. The powerful grasping force damages the sutured side during ligature. It is important to ligate the sutures by carefully monitoring their tension.

## CONCLUSIONS

We reported a case of hybrid extended robotic surgery with arterioplasty. Hybrid robotic surgery may be the next minimally invasive approach without severe postoperative pain and with better functional and cosmetic outcomes.

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