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(Citation)
General Thoracic and Cardiovascular Surgery,71(12):730-732

(Issue Date)
2023-12

(Resource Type)
journal article

(Version)
Accepted Manuscript

Consoler and bedside surgeon fused robotic thoracoscopic surgery

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Keywords: Fusion surgery, Robotic-assisted thoracic surgery.

Abstract

In the last decade, even thoracic surgery has seen an increase in the use of robotic surgical systems, and robotic-assisted thoracic surgery (RATS) is considered one of the main issues. While RATS is associated with solo manipulative freedom and high-definition optical systems, several disadvantages, such as the lack of tactile sensation and difficult learning curves for the whole team, have been raised. Therefore, to overcome these issues, we developed a 'fusion surgery' approach combining a robotic procedure with manual maneuvers, where the table surgeon retracts the lung and staples the pulmonary vasculature and bronchus. Herein, we introduce our 'fusion surgery' procedure and elaborate on its advantage from technical and educational perspectives.

Introduction

With the global trend towards minimally invasive surgery, the robotic approach has gained popularity among general thoracic surgeons, and following this trend, we have introduced and experienced robotic surgery since 2018. Although the main concept of robotic surgery is solo surgery, which enables the high-quality maneuverability and adaptability to any angles by console surgeon, its effectiveness in thoracic surgery remains controversial [1, 2]. Several drawbacks, such as the lack of tactile sensation, higher cost, prolonged operative times (especially operation preparation), issues of education for young surgeons, and difficult learning curves for the whole team, have been raised thus far [3]. Therefore, to overcome these limitations, we have developed a systematic 'fusion surgery' approach combining a robotic procedure with manual maneuvers, where the table surgeon retracts the lung and staples the pulmonary vasculature and bronchus from the assist port in order to both perform and teach this and other robotic thoracic operations better.

In this report, we introduce our 'fusion surgery' procedure and its operative results using robotic-assisted thoracic surgery (RATS) with 4 robotic arms and elaborate on its advantages based on our consecutive experiences.

Technique

In RATS using da Vinci X and Xi and a carbon dioxide (CO_2) insufflation system, four linear ports, including the camera port, were placed in the 8th or 9th intercostal space in all procedures, except for left upper lobectomy, where four ports were placed in the 7th or 8th intercostal space. The representative image of port location is shown in Figure 1. The access port used by the bedside surgeon was placed in the 4th intercostal space on the anterior axillary line for upper lobectomy and the 5th intercostal space on the anterior axillary line for middle and lower lobectomy. During the procedure, the table surgeon can collaborate with the console surgeon through an assist window.

In particular, the table surgeon can retract the lung, dissect the pulmonary artery, vein, and bronchus via the access window, and suction or coagulate to maintain a clear operative field using a suction coagulator (Figure 2). Using the specific CO_2 insufflation system (AirSeal® system (SurgiQuest, Inc., Milford, USA)) which enables a stable pneumothorax with continuous smoke evacuation and CO_2 recirculation during surgery, table surgeon can use suction coagulator under the CO_2 insufflation. Moreover, if emergent conversion to thoracotomy is required, the extension of the assist window can be easily utilized. In cases where the direction of insertion of the stapler from the assist window did not correspond to the pulmonary vasculature and bronchus, the manual stapler was inserted through the other ports. Figures 2A and 2B show each procedure for inserting the manual stapler through the assist window and other ports. When we reinsert the robotic port, the marking tape wrapped around the port helps to fix the remote center easily. These ingenuities are helpful for rapid port-exchange procedures, which is shown in supplementary movie for better understanding.

Anatomical pulmonary resections were performed, including 301 lobectomies and 51 segmentectomies. The average operative times for lobectomies and segmentectomies were 178 and 179 min, respectively, and the blood loss volumes were 24 and 7 ml, respectively. These results are comparable to those obtained using the conventional thoracoscopic approach. We experienced only two cases that were converted to the open approach due to catastrophic bleeding from A3 in the left upper lobectomy and injury of the internal mammary artery during the reconstruction of the pericardium.

Comments

Since Melfi first introduced robotic surgery in the field of thoracic surgery [4], due to its remarkable 3D visual field and high-quality instrument maneuverability, there has been a noteworthy increase in the popularity of RATS. However, its role and potential disadvantages have not been well illustrated. To establish our RATS team and proceed with surgical procedures smoothly, we developed ‘fusion surgery’ where console surgeons and table surgeons cooperated with each other during each procedure.

Inserting manual staplers through each port enables adaptability to any angle and compensates for the lack of tactile sensation related to the Da Vinci staplers. Moreover, all new robotic technologies emerging over the next couple of years, such as the Hugo^{TM} RAS System (Medtronic, Minneapolis, USA) and Hinotori Surgical^{TM} Robot System (Medicaroid Corporation, Kobe, Japan), are designed so that the mechanical stapler is inserted from outside the body. Therefore, thoracic surgeons and their assistants should be familiar with this ‘fusion’ technique.

While RATS might be more beneficial for overweight and obese patients regarding instrument maneuverability [5], its application for underweight patients with small thin thoraces would be relatively difficult because the robotic arms and instruments might be ‘sword-fighting’ inside and outside of the body. Considering the different physiques of Asian and Westerner patients, manual maneuvers would be effective for smooth RATS, avoiding mechanical interference during the operation.

Fusion surgery has educational advantages. Although high-quality surgery should be maintained, it is incumbent on academic surgeons to teach younger thoracic surgeons how to safely perform minimally invasive surgeries. However, in Japan, console surgeons are currently limited to those with a board of thoracic surgeons certification. Fusion surgery can assist young surgeons in performing robotic surgery. In our method, the table surgeon can use curved suction or a cotton swab to expand the operative view and a mechanical stapler or energy device to dissect the vasculature, which could help improve their surgical skills and efficiency.

Thus, given the potent capabilities described above, establishing fusion surgery would contribute to establishing straightforward robotic surgical teamwork. We believe that robotic and manual approaches will outweigh the solo approach, which will continue to evolve and contribute to optimal operative outcomes in thoracic surgery.

Funding:

The authors declare no funding resources.

Conflict of Interest:

The authors declare no conflicts of interest.

Figure legend

Figure 1. The representative image of port location in our ‘Fusion surgery’.

Figure 2. The table surgeon can help clear and maintain the operative view by using curved suction and cotton swabs.

Figure 3. A mechanical stapler can easily be inserted through the assist window (A) and the other ports (B).

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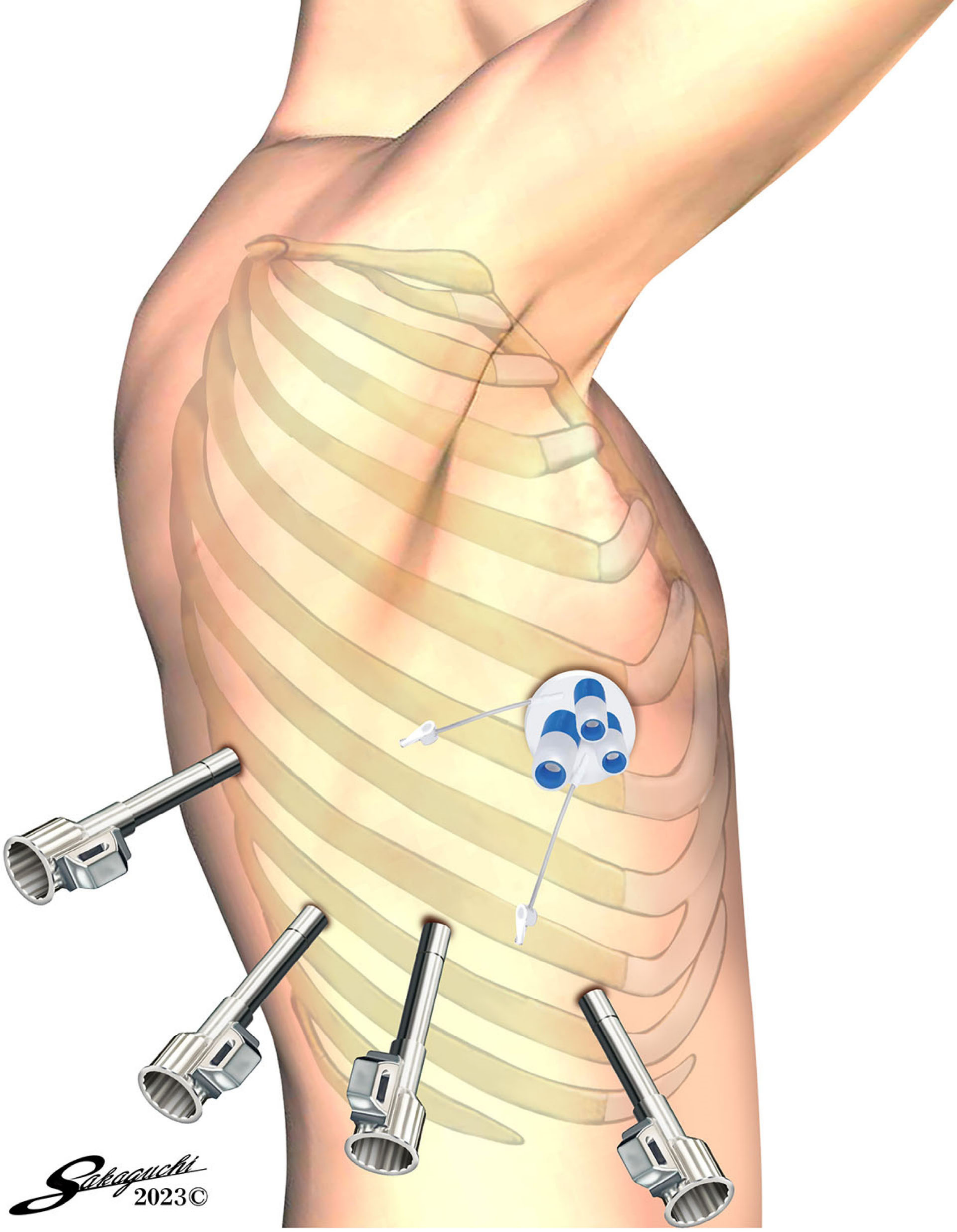
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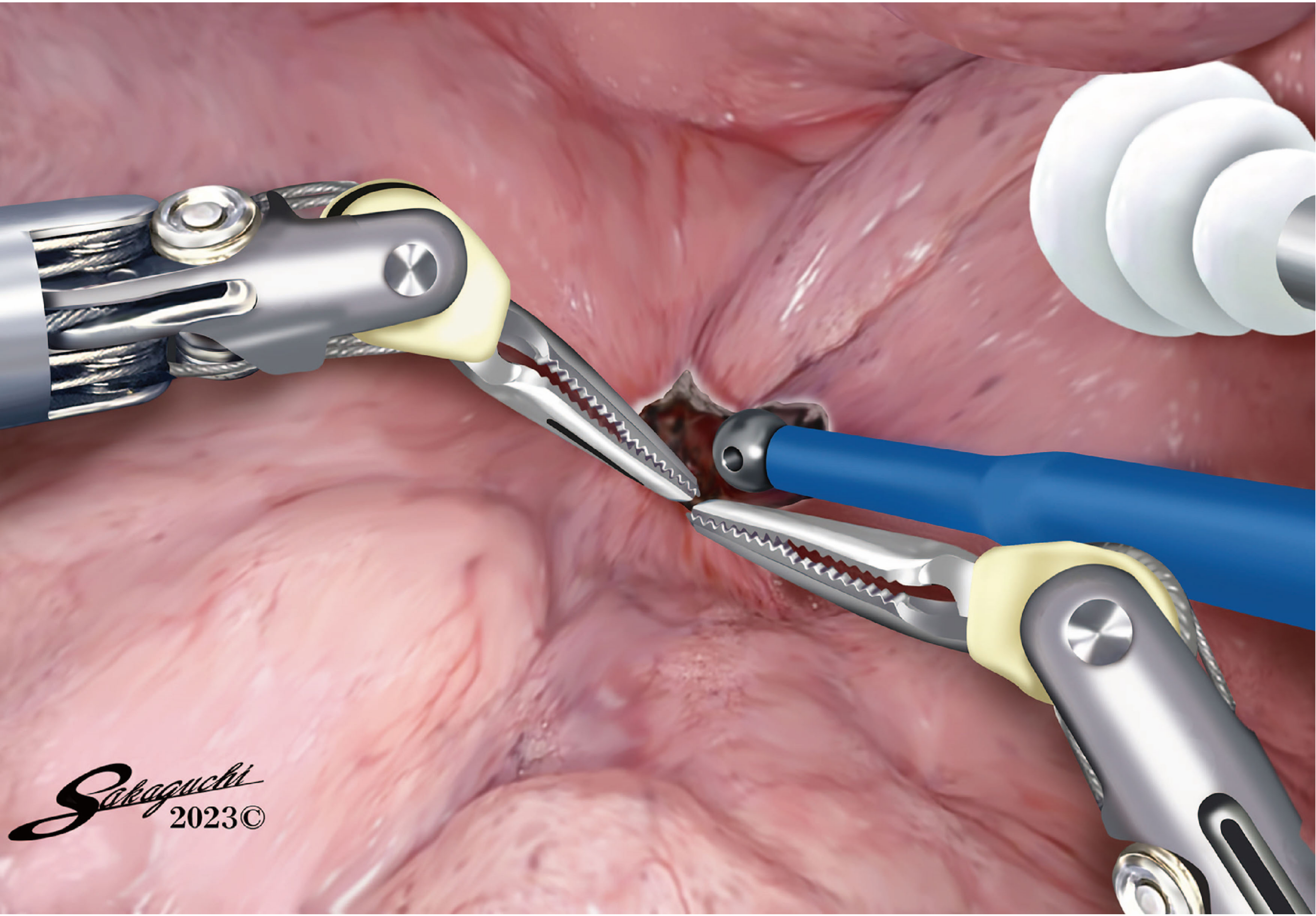
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