Improved complete portal 4-port robotic lobectomy for lung cancer: 'Hamamatsu Method KAI'

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Research Article

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Abstract

Background: Robotic-assisted thoracic surgery has been widely used in the treatment of lung cancer. We devised a new port arrangement at robot-assisted thoracoscopic surgery for lung cancer, the “Hamamatsu method” to provide a good cranial field of view using the da Vinci Xi surgical system, last year. It consists of four robot ports and one assist port, while our video-assisted thoracoscopic lobectomy is performed with four ports.

Methods: By combining the access port and camera port of “Hamamatsu Method”, we devised the 4-port “Hamamatsu Method KAI” equivalent to the conventional 5-port method without changing the operability. Then, in order to prove the safety of “Hamamatsu Method KAI,” the bleeding volume, drain placement period, operation time, and console time were compared with the conventional 5-port case.

Results: In 18 cases of lung cancer who underwent anatomical lung resection by “Hamamatsu Method KAI,” there was no significant difference in bleeding volume, drain placement period, operation time, and console time compared with the conventional 5-port case. No thoracotomy conversion case was detected.

Conclusions: Robotic surgery should not ideally increase the number of wounds than thoracoscopic surgery to preserve the minimal invasiveness advantage. Furthermore, patients are generally more sensitive to wound size and number than what surgeons assume. Therefore, we devised a method to reduce the number of ports without degrading the robotic surgery quality. The improved 4-port “Hamamatsu Method KAI” method combines the access port with the camera port and helps ensure minimal invasiveness while maintaining the same feasibility as the original method.

Background

Robot-assisted thoracoscopic surgery (RATS) has been adopted rapidly in the last decade worldwide. Likewise, in Japan, the number of patients undergoing RATS lobectomy is increasing, rapidly replacing traditional video-assisted thoracoscopic surgery (VATS). This is because RATS using the da Vinci Surgical System® (Intuitive Surgical Inc., Sunnyvale, CA, USA) has been covered by the medical insurance system since April 2018.

There are two main VATS techniques in Japan. One is the “Himeji-style VATS” developed by Miyamoto with a look-up view, wherein the camera is inserted into the chest cavity from the caudal intercostal space.[1] The other is the “confronting upside-down monitor setting type” developed by Kohno[2] and Mun[3], wherein the camera is inserted from the upper intercostal space. While both are good VATS surgical methods, the “confronting upside-down monitor setting type” from the latter method is better for the cranial field of view. Furthermore, since the “confronting upside-down monitor setting type” shows the exact same field of view as open thoracotomy, the transition from an open thoracotomy to VATS is smooth. Thoracic surgeons performing VATS with the “confronting upside-down monitor setting type” like

us have expressed interest in performing RATS with a similar perspective. Yamazaki *et al.*[4] reported an original anterior approach.

We earlier established a new port arrangement, the “Hamamatsu method,” to provide a good cranial field of view using the da Vinci Xi surgical system.[5] However, our video-assisted thoracoscopic surgery is performed with four ports, while the “Hamamatsu method” requires five ports, including the assist port. We developed a new method called the “Hamamatsu Method KAI,” which uses four ports without changing the operability. “KAI” is a suffix in Japanese indicating sequel or successor.

Methods

Since this study is "Non-Experimental Surgical Innovation", IRB review and approval is not required. All study participants provided informed consent.

Surgical technique: Port placement (right upper lobectomy) (Fig. 1)

1. The first port was a 12 mm port in the eighth intercostal space in the anterior axillary line. This was docked to robotic arm four and used for the robotic stapler or the surgeon’s right hand to operate the retraction.

2. At 8 cm posterior to the first port and also in the eighth intercostal space, an 8 mm port was placed for robotic arm three. This was handled using the surgeon’s right hand.

3. At 8 cm posterior to the second port and also in the sixth intercostal space, a 30-mm access port was placed. An alnote® lap single (Alfresa Pharma Corporation, Osaka, Japan) was attached to the access port (Fig. 2) and an AirSeal® (Conmed Japan K.K., Tokyo, Japan) was passed into the lap single. Carbon dioxide (CO_2) was pumped at 8 mmHg. An 8 mm port was also passed into the lap single for robotic arm two. This was used for camera.

4. The fourth port was an 8 mm port on the ventral side of the scapula of the fourth dorsal intercostal space. This was handled using the surgeon’s left hand.

Key considerations

1. By using boom rotation of the da Vinci Xi surgical system, the patient’s cart was always inserted straight from the head side of the patient even in the left and right lateral decubitus position or supine position.
2. Since the port of the anterior axillary line is close to the diaphragm attachment, it should be inserted while observing from inside the thoracic cavity.
3. The patient's right arm should be positioned such that the shoulder blades are as far back as possible.
4. An 8-mm robotic port should be placed on the ventral edge of the 30-mm access port and supported by an assistant from the dorsal side.

Results

In 20 cases of lung cancer who underwent anatomical lung resection by “Hamamatsu Method KAI,” there was no significant difference in bleeding volume (7.5 ml vs. 15 ml), drain placement period (2 days vs. 3 days), operation time (206 min vs. 210 min), and console time (137 min vs. 162 min) compared with the conventional 5-port case (n = 81). No thoracotomy conversion case was detected (0% vs. 11%).

Discussion

In standard surgery for lung cancer, either VATS or RATS, surgical specimens must eventually be removed from the chest cavity, which necessitates a few centimeters of incision. Ninan and Dylewski[6] were the first to popularize robotic lobectomy using three robotic arms without an intercostal access thoracotomy, wherein the surgical specimen was removed through the transdiaphragmatic subcostal access. However, if small incision is required, using it as a utility incision is more convenient. Later, Cerfolio[7] described the completely portal robot lobectomy with four arm (CPRL-4) method using all robotic arms and an assistant port. This technique provided a slightly modified, completely portal robotic approach using three arms developed and championed by Ninan and Dylewski[6], and requires five ports, including an assistant access port. Our previously reported “Hamamatsu Method” also consists of four robotic ports and one assist port, making it a 5-port operation. However, we usually perform thoracoscopic lobectomy using four ports. We believe that the number of ports in robotic lobectomy should not exceed those in VATS to preserve the minimal invasiveness advantage. Furthermore, patients are generally more sensitive to wound size and number than what surgeons assume. Therefore, we devised a method to reduce the number of ports without degrading the robotic surgery quality. CO_2 insufflation is essential in both “Hamamatsu method” and “Hamamatsu method KAI” to secure working space for forceps and cameras in the thoracic cavity. The AirSeal® system and the alnote® lap single can help maintain CO_2 effectively while maintaining assistant access.

The reason for integrating the access port and the camera port is that the camera port requires/involves the least movement. It is also quite possible that the assisting table surgeon is hit by the robot arm. We reduced that risk by connecting the least moving camera port to the access port. The camera is inserted from the ventral edge of the access port, so there is no problem in handling it. In addition, the access port and the camera port have been combined, but the mobility of the three robot arms is completely unaffected.

“Hamamatsu Method KAI” has certain limitations. The two groups were not randomized. Moreover, the “Hamamatsu Method KAI” is a more recent operation. Therefore, based on these results, it cannot be stated that the “Hamamatsu Method KAI” is superior. In contrast, we believe that the “Hamamatsu Method KAI” is not significantly inferior to the conventional method, and a validation study is required to compare it with the conventional method. Pain associated with the surgery should also be taken into consideration.

Conclusions

This “Hamamatsu Method KAI” an improved version of the conventional “Hamamatsu Method” is an epoch-making RATS technique that enables 4-port surgery by reducing the number of ports while maintaining the same operability as that of the conventional method. It is an option for RATS for lung cancer.

Declarations

- Ethics approval and consent to participate

This “Hamamatsu Method KAI” is a "non-experimental surgical innovation" and does not require IRB review and approval. The data analysis part of this study was approved by the Ethics Committee of the Hamamatsu University School of Medicine and carried out in accordance with the principles of the Helsinki Declaration. All study participants provided written informed consent.

- Consent for publication

Not applicable.

- Availability of date and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on friendly request.

- Competing interests

The authors declare no competing interests.

- Funding

None.

- Authors’ contributions

KF, AK, YT and KM were involved in study design and data interpretation, and performed the surgeries. KF, AK, YT, KM and NS were involved in the data analysis. All authors critically revised the report, commented on drafts of the manuscript, and approved the final report.

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Figures

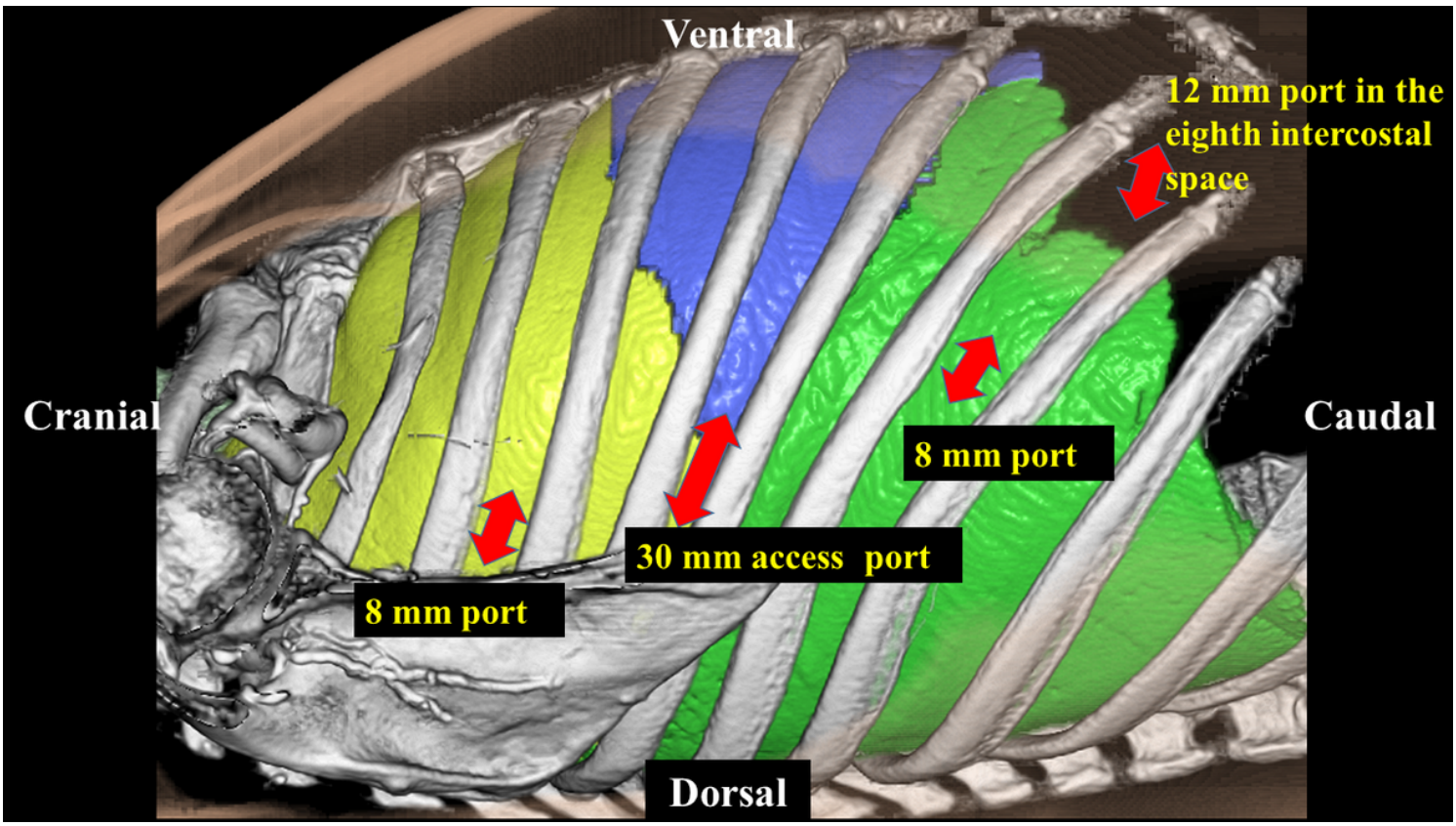

Figure 1

Port arrangement in the Hamamatsu method KAI. Four robotic arms are docked to the four robotic ports. From the cranial side, they become the left hand (8-mm port), camera (30-mm access port), surgeon's

right hand for initial maneuvers (8-mm port), and surgeon's right hand (to operate the retraction arm and stapler; 12-mm port).

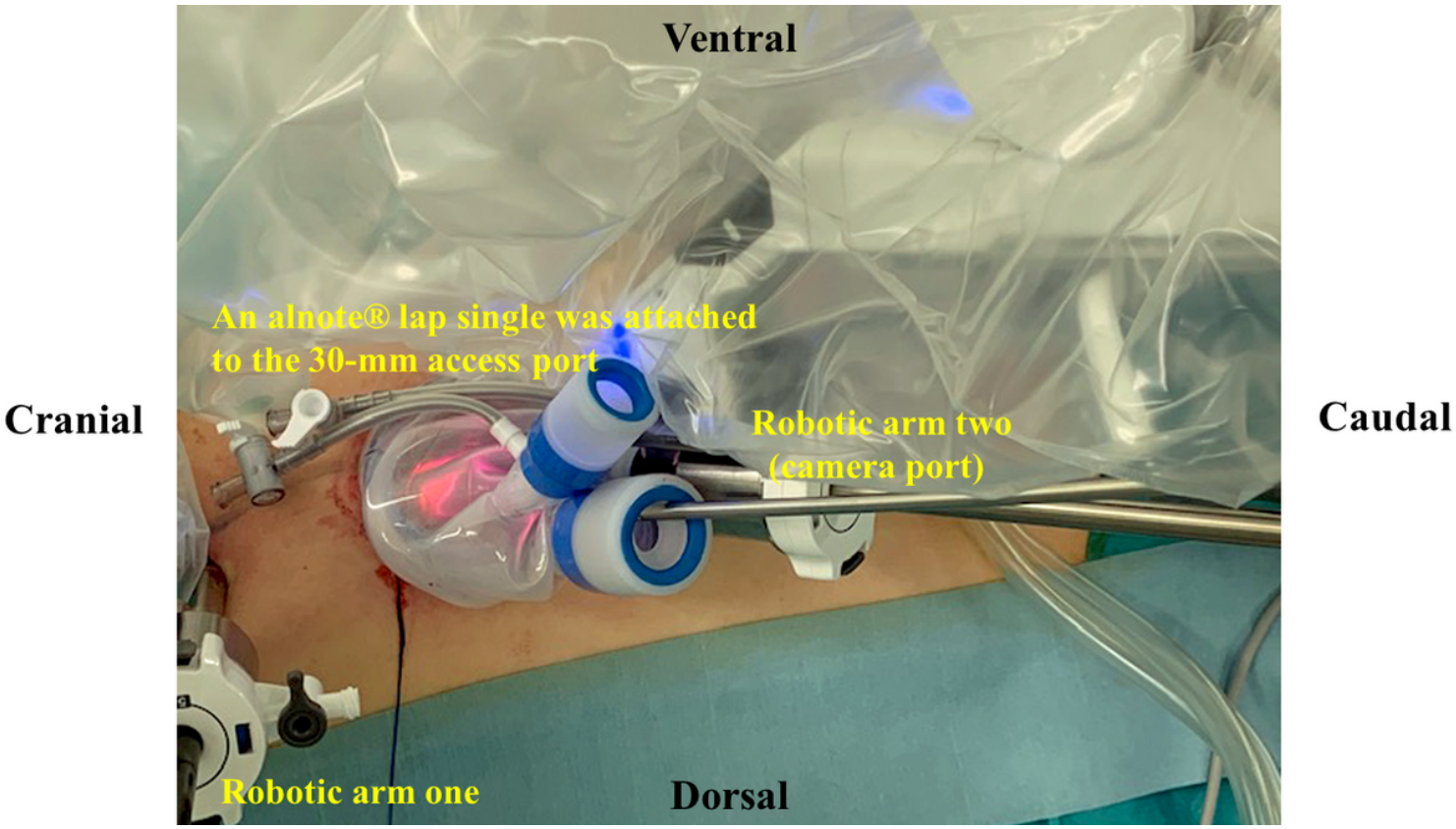

Figure 2

An alnote® lap single was attached to the 30-mm access port. An 8 mm port was passed into the lap single on the ventral edge of access port for robotic arm two. This was used for camera.