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Case Report

Maximizing Use of Robot-Arm No. 3 in Da Vinci–Assisted Thoracic Surgery

Naohiro Kajiwara[1,2], Junichi Maeda[1], Koichi Yoshida[1], Yasufumi Kato[1], Masaru Hagiwara[1], Masatoshi Kakihana[1], Tatsuo Ohira[1], Norihiko Kawate[2], Norihiko Ikeda[1]

[1]*Department of Surgery, Tokyo Medical University, Tokyo, Japan*

[2]*Department of Health Science and Social Welfare, Waseda University School of Human Sciences, Saitama, Japan*

We have previously reported on the importance of appropriate robot-arm settings and replacement of instrument ports in robot-assisted thoracic surgery, because the thoracic cavity requires a large space to access all lesions in various areas of the thoracic cavity from the apex to the diaphragm and mediastinum and the chest wall.[1–3] Moreover, it can be difficult to manipulate the da Vinci Surgical System using only arms No. 1 and No. 2 depending on the tumor location. However, arm No. 3 is usually positioned on the same side as arm No. 2, and sometimes it is only used as an assisting-arm to avoid conflict with other arms (Fig. 1). In this report, we show how robot-arm No. 3 can be used with maximum effectiveness in da Vinci-assisted thoracic surgery.

Key words: Robotic surgery – da Vinci Surgical System – Robot arm

Case Presentation

The da Vinci Surgical System (Intuitive Surgical Inc, Sunnyvale, California) and its later version, the da Vinci S, consist of a surgeon's console connected to the body of the da Vinci, a robotic manipulator unit with 4 instrument arms, including a central arm guided by the endoscope camera, to which the surgeon's movements are transmitted.[1–5] One port is used for the central arm with a three-dimensional (3-D) camera placed in the sixth to seventh intercostal space on the midaxillary line, while 3 other ports are usually used for arm No. 1 (as the right hand in thoracic surgery), arm No. 2 (the left hand in thoracic surgery), and arm No. 3 (as the assisting left hand in the thorax, although some surgeons just keep it in reserve) placed in different intercostal spaces for thoracic

Corresponding author: Naohiro Kajiwara, MD, Department of Surgery, Tokyo Medical University, 6-7-1 Nishishinjuku, Shinjuku-ku, Tokyo 160-0023, Japan.
Tel.: +81 3 3342 6111 (ext. 5070); Fax: +81 3 3349 0326; E-mail: kajiwara@tokyo-med.ac.jp

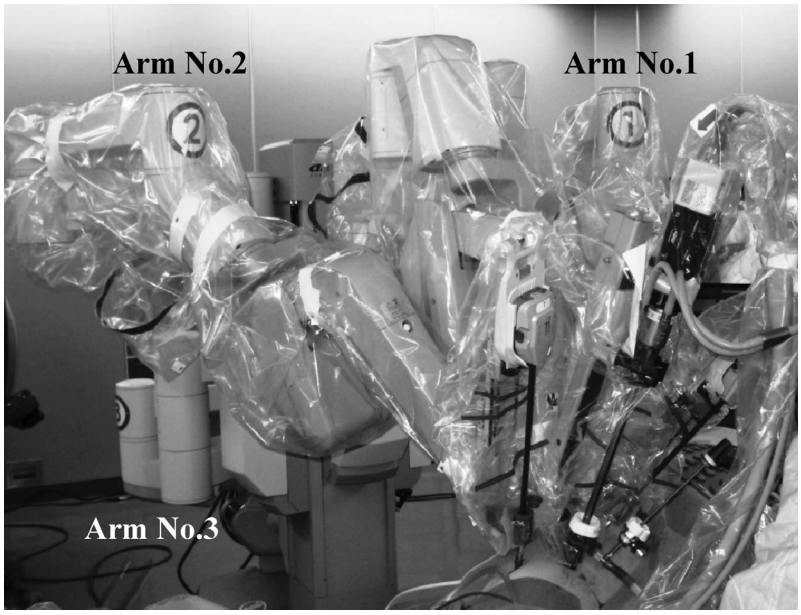

Fig. 1 Usual positioning of arms No. 1, No. 2, and No. 3.

disease in general. In our previous report of the da Vinci, arm No. 3 was usually positioned on the same side as arm No. 2, and sometimes it was used as an assistant arm to avoid conflict with other arms.[1–3]

A 62-year-old man had an anterior mediastinal tumor suspected to be noninvasive thymoma. On diagnostic imaging, the tumor was a well-defined round nodule $18 \times 27 \times 10$ mm in size. The patient was placed in a semilateral position. The lower limbs of the patient were flexed downward so that the pelvis did not impair the movement of the instrument arms. The central 3-D camera port was placed in the area of the seventh intercostal space on the anterior axillary line. Instead of arm No. 1, arm No. 3 was placed in the sixth intercostal space in the midaxillary line inserted from the reverse side, rotating it behind the body of da Vinci S (Fig. 2A). Arm No. 1 was stored behind the body of the da Vinci S to prevent conflict with other arms. Arm No. 2 was placed in the fifth intercostal space in the anterior axillary line (Fig. 2B). We attached the Permanent Cautery Spatula for arm No. 3 and Fenestrated Bipolar Forceps for arm No. 2.

The time required for da Vinci setting was 12 minutes, and the console time (the da Vinci working time) was 75 minutes. Thymectomy was performed successfully, and the amount of bleeding was 68 mL;

Fig. 2 Arm positioning of this study. (A) Comparison between arms No. 1 and No. 3, rotated behind the body of the da Vinci S. (B) Arms No. 2 and No. 3 were inserted as operation arms of the da Vinci S. Arm No. 1 was stored behind the da Vinci S.

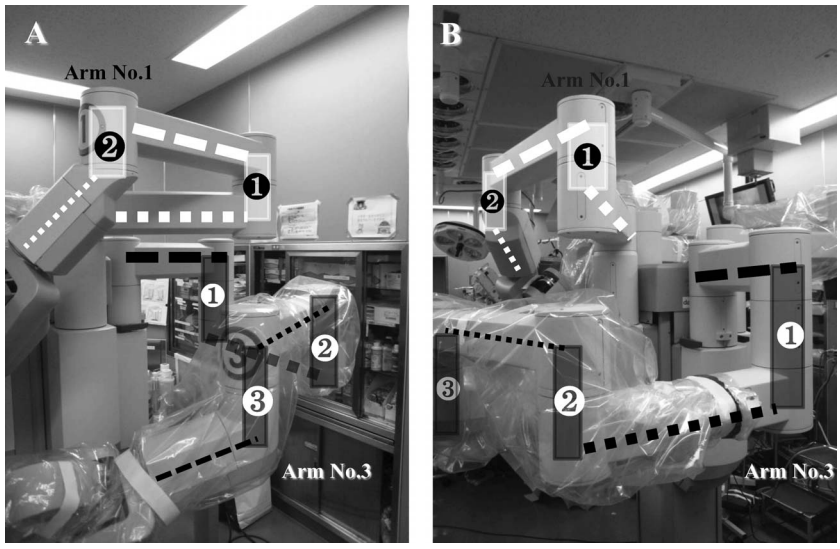

Fig. 3 The joints of the arms of the da Vinci S. (A) Detailed placement of the joints of arms No. 1 and No. 3. (B) The photograph from the posterior of the da Vinci S showing arms No. 1 and No. 3.

there were no complications. The pathologic findings were thymoma, Masaoka stage II.

Discussion

Robotic surgery using the da Vinci system has been approved for various specialties in different countries. However, thoracic tumors can be located at various sites in individual patients. In particular, crucial factors for successful procedures in da Vinci–assisted thoracic surgery are the selection of the appropriate placement and the angle of the instrument ports selected individually in relation to the target and patient position, which vary according to the tumor location.[1–3] The distance separating each da Vinci instrument port is at least 8 cm to prevent interference from other arms. Furthermore, the distance separating each da Vinci instrument port from the target is at least 10 to 20 cm to secure sufficient working space within the thoracic cavity. Moreover, once all the da Vinci devices and equipment are positioned, it is extremely difficult to reset the da Vinci system after the operator starts manipulation in the console. Therefore, instead of using arm No. 1, we found that operations performed by setting arm No. 3 in advance were accomplished smoothly, with good manipulation of the da Vinci in the narrow space of the thoracic cavity.

Arm No. 3 has wider range of motion than other arms because it has one more additional joint (Fig. 3A and 3B). That is why arm No. 3 enables good operability and makes it possible to reach remote lesions, such as in the apex, diaphragm, or costophrenic angle. When we use arms No. 2 and No. 3, it is necessary to insert both arms into the thorax as horizontally as possible to approach the lesion. Moreover, the space between the camera arm and arm No. 3 allows more working space than using arm No. 1 and avoids conflict between arms. This method of using the da Vinci arms should be helpful in robotic procedures for thoracic surgeons when manipulating the da Vinci instrument arms.

Our recent experience has shown that arm No. 3 is extremely useful as the main arm in place of arm No. 1. This approach should be helpful for da Vinci–assisted thoracic surgery procedures, especially in manipulations requiring a steep angle for lesions such as in the apex or diaphragm, or costophrenic angle.

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