Editorial

Usefulness of robot-assisted surgery for lung cancer demonstrated from the patient's perspective

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When demonstrating the usefulness of new surgical techniques, it is important to not only show that the technique concerned is comfortable for the surgeon but also show that it is beneficial for the patient.

Upon conducting a systematic and comprehensive review of the literature, Liang *et al.* performed a meta-analysis of the initial perioperative results of robot-assisted lobectomy/segmentectomy (RAL/S) compared with those of video-assisted lobectomy/segmentectomy (VAL/S) for lung cancer (1). They analyzed 14 studies, including 7,438 patients, and reported that the 30-day mortality [0.7% *vs.* 1.1%; odds ratio (OR), 0.53; P=0.045] and conversion-to-open surgery (10.3% *vs.* 11.9%; OR, 0.57; P<0.001) rates were significantly lower in patients who underwent RAL/S than in those who underwent VAL/S. The meta-analysis revealed that the rate of postoperative complications, operative duration, length of hospital stay, days to tube removal, retrieved lymph node, and retrieved lymph node station were similar between the two groups. The investigators concluded that the meta-analysis confirms that RAL/S is a feasible and safe alternative to VAL/S for radical resection of lung cancer. Although it has been reported to date that robot-assisted surgery is more effective compared with conventional video-assisted thoracic surgery (VATS) performed by humans, there have been few meta-analyses (2). Thus, this meta-analysis is an important report demonstrating the effectiveness of robot-assisted surgery.

Shortcomings of VATS include the fact that surgery is performed with a two-dimensional visual field using long and rigid instruments, which impede surgical manipulations from being performed via a natural approach. Furthermore, in VATS, hand suturing the bronchial tubes and delicate suturing operations, such as angioplasty, can be difficult. Therefore, surgical procedures with such a high level of difficulty generally are performed via open thoracic surgery. To compensate for these shortcomings of VATS, robot-assisted systems were developed. The daVinci surgical system (Intuitive Surgical, Sunnyvale, CA, USA) provides forceps that move like the joints of human hands and clear three-dimensional (3D) images, thereby enabling separation, resection, and suturing operations to be performed via a natural approach even in the narrow thoracic cavity. Furthermore, removing physiological tremor, providing magnification, and increasing the degree of motion (motional scaling function) facilitate more delicate operations than the ones that can be performed by human hands. However, how robot-assisted surgery is beneficial for the patient compared with VATS remains unclear.

Robot-assisted surgery may be superior to VATS in terms of safety and reduced incidence of complications due to its superior operability, with more accurate diagnosis of lymph node metastasis resulting from easier lymph node dissection requiring deep operations, thus providing improved long-term outcomes. Furthermore, VATS operations using long straight instruments lead to pressure on the thoracic wall, particularly on the intercostal nerves located below the ribs,

resulting in postoperative nerve damage. In robot-assisted surgery, the fact that the forceps have articulations within the thoracic cavity means that intercostal nerve compression can be avoided, resulting in the reduction of nerve damage. Moreover, robot-assisted surgery with articulations might facilitate surgical procedures that have a high level of difficulty in VATS, such as bronchoplasty.

With regard to the initial outcomes of robot-assisted surgery compared with VATS, conflicting results have been reported. Compared with VATS, robot-assisted surgery has been shown to be minimally invasive, with less blood loss, shorter hospital stays, less postoperative complications, and less use of analgesics (3-7). In contrast, robot-assisted surgery also has been reported to be more costly, with a longer operative duration and increased hemorrhage (8-10). Robot-assisted surgery may theoretically provide a potential to reduce intercostal nerve damage, but there are few evidence in terms of postoperative pain under robot-assisted surgery (11).

Furthermore, in recent years, the long-term outcomes of robot-assisted surgery have been reported; however, the results were comparable to those of open thoracic surgery and VATS (12,13). Presently, problems of robot-assisted surgery include prolonged operative duration and thus longer occupancy of the operation theater resulting in inefficient application and use of medical resources as well as high cost; moreover, the usefulness of this technique for the patient has not been shown to offset this increased cost.

This meta-analysis showed that compared with VATS, robot-assisted surgery is superior in terms of the 30-day mortality and conversion-to-open surgery rates. Although it is difficult to examine the reason why robot-assisted surgery results in a reduced 30-day mortality, this finding might demonstrate the safety of this technique. The reason that the conversion-to-open surgery rate is reduced might be the fact that adhesiotomy could be performed and conditions that require delicate suture operations, which are difficult to treat by VATS, could be treated via the superior operability of robot-assisted surgery. Therefore, the conversion-to-open thoracic surgery rate could be reduced. Furthermore, even in surgery that is not difficult, the robot system that enables separation with a 3D visual field and natural approach helps to dissect the tenacious adhesions and reduce the onset of intraoperative complications, such as vascular damage, which might have otherwise lowered the conversion-to-open surgery rate. Further examination is warranted to clarify the reason why the 30-day mortality and conversion-to-open surgery rates were reduced.

With its 3D visual field and excellent operability, the robot system is clearly useful for the surgeon. However, it is difficult to demonstrate the benefits of robot-assisted surgery for the patient. Robot-assisted surgery can be more expensive than VATS; thus, benefits for the patient that offset the high costs must be demonstrated. A major point demonstrated in this meta-analysis was that compared with VATS, robot-assisted surgery was shown to be beneficial for the patient in terms of safety and that there was a high likelihood that surgery be completed with minimal invasiveness.

A weak point of the reports is that all used retrospective data. At present, to our knowledge, no prospective randomized controlled study comparing robot-assisted surgery with VATS exists. As introduced in the present report, a randomized trial (NCT02804893) examining the initial outcomes of robot-assisted surgery compared with those of VATS for stages I and II lung cancer currently is underway (14). In future, the results of a multicenter randomized controlled study are anticipated. Furthermore, the long-term outcomes, including the recurrence and 5-year survival rates, should be evaluated.

The robot system is undergoing continuous improvements, and presently, a stapler can be attached to the robot arm. New developments would then, as a matter of course, increase the usefulness of robot-assisted surgery. In the near future, a robot-assisted surgery system for single-port surgery will be available commercially, and such a system might help uncover new findings. Constant re-evaluation of robot-assisted surgery using continuously improving robot systems is accordingly required as well.

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Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

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