Thoracoscopic Versus Robotic Approaches
Advantages and Disadvantages

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KEYWORDS

• Robotic surgery • Video-assisted thoracoscopic surgery • Esophagectomy

KEY POINTS

- Robotic surgery has grown from a nascent technology into what has become a dominant modality for a variety of surgical fields. In general thoracic surgery the use of robotic technology is increasing.
- As the use of robotics proliferates, it will be important to compare it with established thoracoscopic approaches in a systematic fashion, and to continue to evaluate both technologies in terms of short-term outcomes, long-term oncologic efficacy, and cost.
- Robotic technology has several theoretical benefits compared with more widely utilized VATS approaches, but few data exist demonstrating objective clinical superiority.
- Robotic technology adds additional operating room expense compared with equivalent VATS procedures. This is largely as the result of disposable charges (instruments, drapes).

INTRODUCTION

Thoracoscopic surgery was first reported by Christian Jacobaeus, a Swedish internist in the early twentieth century. Jacobaeus used a cystoscope to assist him in the lysis of the intrathoracic adhesions that would occasionally prevent the successful induction of pneumothorax: collapse therapy for cavitary tuberculosis. This practice, which became known as closed intrapleural pneumolysis, was widely used until the advent of streptomycin in 1945 led to pharmacologic treatment of tuberculosis.[1]

Since then, thoracoscopic surgery has undergone a major resurgence. Initially thoracoscopy, or video-assisted thoracoscopic surgery (VATS), was reserved for basic procedures such as pleural biopsy and drainage of effusions, but the procedures performed currently by thoracic surgeons have become increasingly complex. For example, approximately 45% of pulmonary lobectomies in the Society of Thoracic Surgeons General Thoracic Surgery Database are performed thoracoscopically.[2] In addition, VATS is routinely used in the resection of mediastinal tumors, esophagectomy, pneumonectomy, and chest-wall resections.[3]

The benefits of VATS over thoracotomy include shorter length of stay in hospital, decreased pain and narcotic utilization, improved recovery time, and decreased complications including pneumonia and atrial fibrillation.[4,5] In addition, thoracoscopic lobectomy, as opposed to thoracotomy, has been shown to increase the chances that a patient will receive the appropriate adjuvant chemotherapy.[6] Recently, a randomized controlled trial comparing VATS with thoracotomy in esophagectomy for esophageal cancer has also shown benefits in terms of perioperative pulmonary morbidity, hospital stay, quality of life, postoperative pain, and blood loss.[7] In summary, the overall advantages of thoracoscopy over thoracotomy in terms of patient recovery have been fairly well established.

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The use of robotics, on the other hand, is a newer and less proven modality in the realm of thoracic surgery. Although in some respects an extension of thoracoscopy, in the sense that robotic thoracic surgery allows the surgeon to perform minimally invasive procedures, the use of robotics offers distinct advantages and disadvantages in comparison with VATS. First used in 1985 to perform a neurosurgical biopsy and 3 years later to perform a transurethral resection of the prostate, robotic technology is now used for a variety of complex cardiac, urologic, and gynecologic procedures including mitral valve repair and microsurgical treatment of male infertility.[8,9] The earliest reports of thoracic procedures being done with the assistance of robotics date back to 2002.[10–12] There has been a fairly rapid dissemination of robotic technology in the ensuing decade, with many hospitals in the United States marketing some form of robotic thoracic surgery, despite fairly undefined advantages of the technique. This article addresses the potential benefits and limitations of using the robotic platform for the performance of a variety of thoracic operations.

THORACOSCOPIC VERSUS ROBOTIC THORACIC PROCEDURES

Logistics and Personnel

From the standpoint of planning either a VATS or robotics procedure, familiarity of the operative team with the instruments and setup of the case is critical. At present, the preparation required for performing a robotic thoracic operation is more involved than that for VATS. First, making sure that the robot and console is available for the planned time of the operation is a basic logistical issue that cannot be overlooked. Most hospitals will have only 1 or 2 robots available to their surgeons at any one time, and often require surgeons to prearrange. At present, the only robotic surgery platform being used on patients is the da Vinci Surgical System (Intuitive Surgical; Sunnyvale, CA), which was approved in 2000 by the Food and Drug Administration. This system consists of a 3- or 4-armed robot positioned at the patient's side by the operating table and controlled by a console across the room, away from the sterile area. Coordination with the operating room administrators or, preferably, establishing a set "block time" that ensures robot availability is necessary. The size of the robot and its console(s) may dictate the specific operating room to be used, as certain rooms may be too small to accommodate the equipment and personnel needed. Thoracoscopy, on the other hand, requires only basic video equipment: a scope, a camera, and monitors.

Some hospitals require that the scrub technicians and circulating nurses be credentialed to assist with robotics cases, which adds another level of complexity to arranging these operations. Although this should not understate the desirability of having a dedicated team for VATS cases, there are typically more nurses with adequate training to assist with VATS than with robotics cases.

One disadvantage of robotics is that a skilled assistant, capable of deploying the stapler and performing retraction, is required to be present at the table while the operating surgeon is at the console. This assistant can be a scrub technician, physician assistant, cardiothoracic surgery resident, or even another attending surgeon, depending on the skill required to assist a particular procedure. The assistant, regardless of background, needs to be familiar and comfortable with changing the robotic instruments, troubleshooting port and robotic issues, moving instruments into and out of the thorax safely, passing the stapler around structures that are often vascular in nature, and actively assisting in retraction if necessary. The need for an experienced assistant able to react quickly and effectively to potentially catastrophic bleeding, such as in the case of a ruptured pulmonary artery branch during lobectomy, is a potential disadvantage for the robotic surgeon, who is situated away from the operating table. While communication between team members is critical for any procedure, the challenge in robotic surgery is that nonverbal cues and gestures cannot be conveyed by the surgeon to the rest of team because of their separate locations. In robotics, the surgeon can use the marking software to demonstrate structures and transmit directions to the team on the video screen; during VATS, the surgeon can directly show the assistant what to do with the instruments.

One advantage of robotics is that the surgeon controls the camera, negating the need for a skilled camera operator as is needed during thoracoscopy. On the whole, however, the personnel training, requirements, and codependence in robotic surgery are generally more demanding than those in thoracoscopy.

Positioning, Port Setup, and Camera

Patient positioning is generally similar in thoracoscopic and robotic approaches to the same operation. For robotic cases, the position of the robot in the room relative to the patient should not be overlooked. In general, the surgeon should plan on having the robot approach the patient from the opposite direction of the planned orientation of the instruments. Docking the robot does require