Robotic Resection of a Superior Sulcus Neurogenic Tumor

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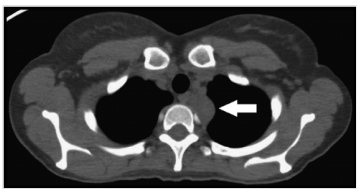
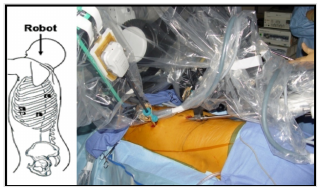
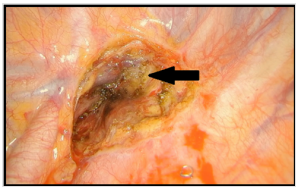
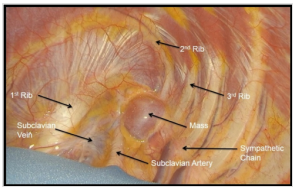
Abstract

Objective: Neurogenic superior sulcus tumors are rare. Historically there have been multiple surgical approaches that have been dictated by the location of the tumor and its relation to the contiguous structures such as the vertebral bodies, subclavian vessels, and chest wall. Resection is hampered by difficulties with visualization and access within a narrow working space. The shortcomings associated with the traditional surgical approaches create a potential of…

Figures

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CASE REPORT

Robotic Resection of a Superior Sulcus Neurogenic Tumor

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Abstract: Neurogenic tumors do not often occur in the superior sulcus or apex of the chest cavity. Historically, surgical approaches have been dictated by the location of the tumor and its relation to the contiguous structures such as the vertebral bodies, subclavian vessels, and chest wall. Resection is hampered by difficulties with visualization and access within a narrow working space. The shortcomings associated with the traditional surgical approaches create a potential of injury to nearby structures. We present a case of a 43-year-old woman with a superior sulcus neurogenic tumor impinging on the left subclavian vein, who underwent a successful resection without injury to nearby structures. We found that a robotic approach improved visualization of the tumor and nearby structures and increased instrument maneuverability relative to a

Key Words: Robotic surgery, Thoracic, Superior sulcus, Neurogenic tumor, Thoracic outlet, Schwannoma.

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Neurogenic tumors do not often occur in the superior sulcus or apex of the chest cavity. Their location at the apex of the thoracic cavity is near multiple vital structures including the subclavian vessels, vertebral bodies, and the sympathetic chain.[1] Potential complications of surgical excision are attributable to injury of these structures including Horner syndrome (ptosis, miosis, and anhidrosis) as well as pain and motor deficits of the upper extremity.[2–4] Traditional approaches include anterior or posterior thoracotomy and sternotomy.[2,5–8] These approaches are associated with increased pain, long hospital stays, and high complication rates.[10] Thoracoscopic approaches improve pain and length of stay, but visualization and dissection of the apex can continue to be difficult because of the narrow and distant location of the apex in relation to thoracoscopic ports and the intimate relationship of the tumor to vital structures.[3,4,9–11] Robotic assistance provides enhanced three-dimensional visualization and greater instrument maneuverability within a confined space, making it a promising option for these cases.[12] We report a case of a patient with a neurogenic superior sulcus tumor, who underwent resection by robotic thoracic surgery.

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CASE REPORT

The patient was a 43-year-old woman who initially presented to her primary care physician for mild chest pain and shortness of breath. She had a known history of right-sided pneumothorax status postpleurodesis. She was referred to thoracic surgery for evaluation and management of this apparent recurrent pneumothorax status postpleurodesis. On further clinical history examination, the patient noted having vague left-sided symptoms including numbness and fullness on her left upper extremity. She had no ptosis, miosis, or temperature differences between her hands indicative of Horner syndrome. She also had no gross neurological deficits. Her physical examination result was otherwise negative. Computed tomographic imaging of the thorax was performed to further investigate, which noted no pneumothorax, but rather a 3-cm mildly enlarging mass compared with a previous study that was consistent with a schwannoma (Fig. 1). Furthermore, the computed tomographic scan showed no pleural effusion, pleural abnormalities, or pulmonary nodules to suggest a malignant process. On the basis of her clinical symptoms and her radiological finding, we proceeded with surgery to (1) evaluate the mass thoracoscopically with possible biopsy; (2) perform resection of the mass with robotic assistance if it was consistent with a benign schwannoma.

Technique

The da Vinci system (Intuitive Surgical Inc, Sunnyvale, CA USA) was used for this procedure.

Positioning

After general anesthesia and intubation with a double-lumen endotracheal tube, the patient was placed in the right lateral decubitus position in an inverted V at the hips with arms extended at a 90-degree angle relative to the body.

Incision Placement

A nontrocar technique was used with three 2-cm incisions, from which 8- to 12-mm robotic instruments were

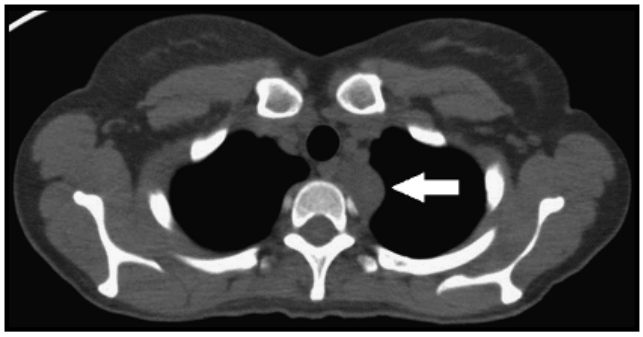

FIGURE 1. Computed tomographic image of superior sulcus mass in transaxial view.

used. The nontrocar technique involved placing the robotic instruments directly through the incisions without use of trocars. The first incision was made in the eighth intercostal space at the midaxillary line for the use of a 30-degree down viewing robotic camera. The second incision was in the fifth intercostal space at the anterior axillary line and a third incision in the sixth intercostal space at the posterior axillary line as shown in Figure 2. At this point, the mass was identified and was clearly a schwannoma because it was well-circumscribed, encapsulated soft tissue mass

at the anterior axillary line. This incision was required for retractor placement and also used for placement of a chest tube at the conclusion of the procedure. Three robotic arms were used in this procedure.

Instruments

An Endo Paddle (Covidien Inc, New Haven, CT USA) was used through incision 4, and the lung was retracted inferiorly. The retractor was fixed to the table with a Fast Clamp (Snowden Pencer, San Diego, CA USA). A hook cautery was placed in the right robotic arm, and long tip forceps was placed in the left robotic arm. A maneuverable metal suction was introduced under the robotic arm through incision 3 and was used for retraction and to keep the surgical field dry.

Dissection

Figure 3 shows the retracted lung, along with the relevant anatomy in this location. Of note, the superior sulcus mass was abutting and impinging on the subclavian vein and was next to the sympathetic chain. The mass arose from the second thoracic sympathetic ganglion.

Dissection began by circumferentially opening the parietal pleural around the tumor with the hook electrocautery. Once the pleura was opened, the tumor was gently retracted with the robotic graspers.

Figure 4 shows careful dissection of the tumor off of the sympathetic chain. As dissection proceeded, direct compression of the tumor onto the subclavian vein could be seen. Injury to the subclavian artery, subclavian vein, and sympathetic chain was avoided during this dissection, thanks to the detailed three-dimensional view of the superior sulcus and its deep structures, along with the articulation of the robotic instruments.

Dissection proceeded with continued gentle retraction of the mass with endoscopic graspers as the plane between the

invading nearby structures, a clear plane could be developed. After removal of the mass, the diameter of the subclavian vein was observed to increase visually, indicating that the extrinsic compression on the subclavian vein was relieved.

Figure 5 shows the superior sulcus after tumor resection. The stellate ganglion was above the fat pad. After resection, a chest tube was placed, and the patient was extubated with no complications.

Pathology

Pathology microscopic examination found this mass comprising bland spindle cells with variable cellularity. The lesional

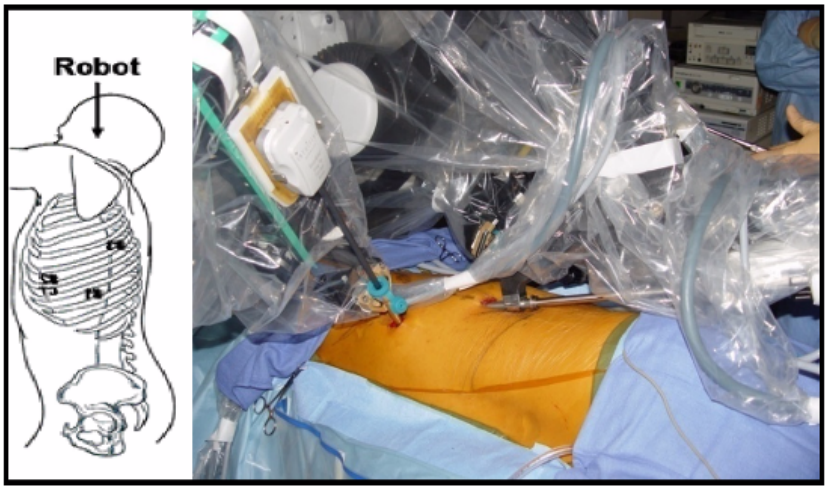

FIGURE 2. Positioning of patient, trocar placement, and positioning for the robot.

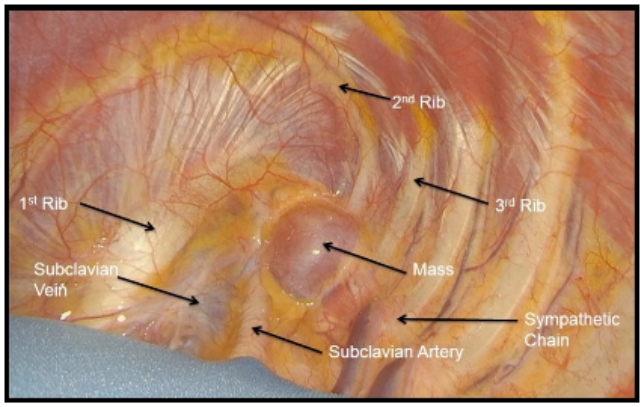

FIGURE 3. Anatomy of the left superior sulcus.

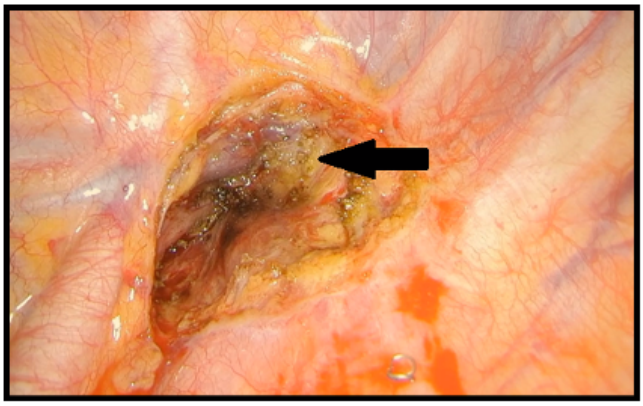

FIGURE 5. Superior sulcus after resection.

cells were strongly positive for S-100 and weakly positive for synaptophysin, consistent with benign schwannoma.

Postoperative Course

The patient had an uneventful postoperative course. She was ambulating and tolerating a diet on postoperative day R 1. After chest tube removal on postoperative day 2, she was

stellate ganglion, leading to Horner syndrome.[2] Macchiarini et al described the need for division of the subclavian vessels to obtain access to the neurogenic tumor of the superior sulcus.[6] Ladas et al[2] reported 75% rate of Horner syndrome using an anterior approach for the resection of the superior sulcus tumor.

The advocates of the apicoposterior approach have em-

DISCUSSION

There is no standard approach for the resection of superior sulcus neurogenic tumors. A variety of alternatives have been proposed including an anterior approach using a thoracotomy and a sternotomy, an apical posterior approach using a posterior thoracotomy, and thoracoscopy.

The anterior approach has been advocated as a means of providing greater exposure to the thoracic inlet and more precision during the dissection. This approach is associated with high rates of injury to the sympathetic chain ganglia or

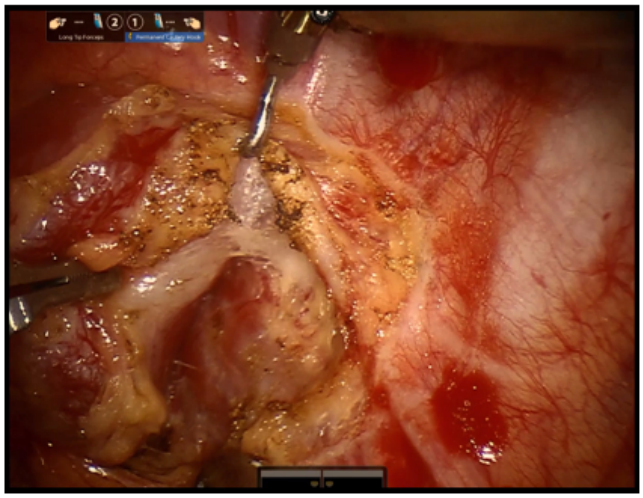

FIGURE 4. Dissection of tumor off of sympathetic chain.

sure.[7–9] Limited studies show the difference in surgical approaches for superior sulcus tumors; however, both anterior and apical posterior approaches have been associated with significant morbidity and prolonged recovery times from the extensive incisions.[13–16]

With the advent of videoendoscopic techniques, the thoracoscopic approach has been advocated for the removal of posterior superior sulcus tumors.[3,4,9–11] Thoracoscopic approaches are associated with lower morbidity due to the smaller incisions. However, with thoracoscopy, limited visualization and instrument maneuverability increase the risk of collateral injury to nearby neurovascular structures.[3] Most reports on this approach come from very specialized centers and may become especially challenging for less specialized centers. Emerging technology in the form of flexible thoracoscopic cameras and robotic technology may allow for these limitations to be overcome.

The surgical robot has the ability to provide high-definition magnified, three-dimensional visualization and scaled instrument maneuverability within a confined space. When used in a thoracoscopic platform, the surgical robot can be a useful instrument for the resection of superior sulcus tumors. Several small case series have shown that robotic resection of mediastinal masses is feasible and safe, although no studies have applied robotics to superior sulcus neurogenic tumors.[17–19]

Our patient presented with a superior sulcus tumor, which was compressing the subclavian vein and was associated with upper extremity symptoms. The hook cautery was used for the resection of the mass. Although the hook cautery provided great maneuverability, it can be associated with injury to nearby structures because of heat transfer. Other authors have advocated the use of the harmonic scalpel, which would

obviate this difficulty. Because the harmonic scalpel is not as maneuverable as a hook cautery, we have found it to be cumbersome when used in a confined space. In our experience, when used at the appropriate settings (monopolar coagulation setting at 30 W) and rapid maneuvers, the hook cautery can be used safely around the neurovascular structures.

We prefer a nontrocar technique as shown in Figure 2 where the robotic instruments enter directly through the incisions. This allows for accurate positioning of the robot and the use of metal suction devices under the robotic arms by an assistant who can help with the retraction and clearance of blood and fluid from the surgical field. The use of this technique does not allow for CO_2 insufflation. Although CO_2 insufflation may be useful in certain instances, we have not found it to be useful in the resection of superior sulcus neurogenic tumors. Other surgeons may prefer to use CO_2 insufflation and reverse Trendelenburg positioning for lung retraction.

Accurate imaging of neurogenic tumors is important because these tumors may arise from any neural structure in the chest, including peripheral nerves, sympathetic chain or ganglia, or parasympathetic chain or ganglia. In cases of dumbbell tumors with intraforaminal or intraspinal involvement, collaboration with neurosurgery or orthopedic spine surgery is recommended preoperatively.

data remain limited because of the low incidence of this tumor.

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