Thoracoplasty in the New Millennium

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Before the development of antituberculosis drugs in the mid-1940s, pulmonary resection and thoracoplasty stood as the primary therapies for the treatment of pulmonary tuberculosis. In the nineteenth century, Parker and Thompson described the use of pneumothorax to partially collapse an empyema cavity. This method, along with unilateral phrenic nerve division, plombage, and pneumonolysis, emerged as therapies for potential obliteration of tuberculous cavities during this period, but complications were common, and these operations were soon outdated. In 1885, Poulet treated a patient with tuberculous empyema by intercostal incision, rib resection, and pleural debridement with subsequent resolution of the cavity. In the last decade of the nineteenth century, several surgeons, including Estlander, Ransahoff, and Schede, described thoracoplasty for the treatment of persistent empyema cavities. Estlander was the first to report such a procedure in 1877. The surgeon Cerenville first reported the resection of the first rib allowing for a resection extended higher in the chest. Sauerbruch, a German surgeon, proposed the modern method of thoracoplasty and first popularized this procedure for the surgical treatment of tuberculosis in 1911. John Alexander developed the modern extrapleural thoracoplasty procedure and described the safe application of this operation for pulmonary tuberculosis. His cavity closure rate in 93% of survivors was coupled with a mortality rate of only 10%. This procedure had a significant effect on our ability to treat tuberculosis. The incidence of mortality from tuberculosis in the United States fell from 300 per 100,000 in 1880 to only 69 per 100,000 in 1937.

Today, thoracoplasty is rarely, if ever used to treat primary pulmonary tuberculosis. However, it remains a treatment option for tuberculosis and pneumonectomy complicated by bronchopleural fistula or empyema. Surgeons in developing countries continue to use thoracoplasty as a primary treatment of pulmonary tuberculosis complicated by empyema, bronchopleural fistula, and drug-resistant mycobacterial strains. Thoracoplasty is better tolerated in patients in poor medical condition who may not tolerate pulmonary resection. Unfortunately, the increased incidence of AIDS over the past decade has led to the resurgence of tuberculosis and atypical mycobacterial infections in immunocompromised, debilitated patients. These patients often respond poorly to the usual drug regimen and will not tolerate pulmonary resection. Therefore, thoracoplasty once again may play a role in the treatment of this select group of patients.

PREOPERATIVE PREPARATION

Before performing thoracoplasty, the surgeon must carefully plan a detailed preoperative strategy. A traditional thoracoplasty removed up to 7 ribs. A modified or limited thoracoplasty removes only 4 or 5 ribs and may be indicated to close a small infected apical space after lung resection. The size of the cavity is the determining factor in planning the extent of resection. The planned resection must be of adequate size to completely close the affected pleural space. A quality posteroanterior chest radiograph will allow the surgeon to determine the inferior extent of the cavity. The deforming nature of this operation creates a significant and permanent loss of unilateral ventilatory capacity. Thus, pulmonary consultation and formal pulmonary function tests are vital in assessing the patient’s ability to tolerate such a resection. Today, surgeons combine limited thoracoplasty with new plastic techniques to limit the extent of rib resection and chest wall deformity.
Once adequate general anesthesia has been administered, the patient is positioned in the lateral decubitus position with the operative side up. The incision is an extended version of a standard posterolateral thoracotomy. A long parascapular incision beginning approximately 4 to 5 cm below the upper edge of the trapezius muscle is extended along the medial aspect of the scapula’s vertebral border and around the scapula tip. The muscle fibers of the underlying trapezius are divided with electrocautery. The rhomboideus major and minor muscles are separated from the scapula’s vertebral border. Next, the upper portion of the latissimus dorsi muscle is divided in a direction approaching the scapular angle. The scapula is retracted from the rib cage to widely expose the posterolateral chest wall.
The serratus anterior muscle is detached approximately 1 cm from its insertion on each rib. This maneuver exposes the anterolateral aspect of ribs 3, 4, and 5. Posteriorly, the attachments of the serratus posterior and the erector spinae muscles are divided, exposing the posterior aspect of these ribs. These maneuvers will completely expose ribs 3, 4, and 5 from the edge of the sternum to the vertebral border. A Finochette retractor is placed to retract the scapula and overlying musculature away from the chest wall as shown above.
The posterior attachments of the serratus posterior muscle are divided from the 2 upper ribs. Division of this muscle brings the subclavian artery and brachial plexus into view. These structures must be carefully guarded from injury. The periosteum of the second and third ribs is elevated, with care taken to not violate the parietal pleura. Next, the superior and inferior muscle attachments are bluntly separated from both ribs, carefully avoiding the neurovascular bundle traveling along the inferior border. Transection of both ribs occurs at the articulation of the rib with the transverse process of the appropriate vertebrae. Once the neck of the rib is separated from the transverse process, the rib is grasped with bone forceps and the remaining posterior ligamentous attachments are detached by firm rotational force. The ribs are elevated and divided at the level of the rib cartilage near the sternal border. The second and third ribs are resected first to maximally expose the first rib. Next, the periosteum along the inferior border of the first rib is elevated. The subperiosteal dissection is continued toward the superior border of this rib. This maneuver, in an inferior to superior direction, ensures safer dissection in the region of the subclavian artery and brachial plexus that lies in close proximity to the superior border of the first rib. The head of this rib is not disarticulated; the rib is transected just distal to its head. Transection at this level minimizes the risk of injury to the nearby stellate ganglion. This rib is elevated to expose the scalene muscle, which is divided at its tendinous attachment. The first rib is then transected anteriorly at the level of the rib cartilage and is removed.
To complete a 5-rib thoracoplasty, the fourth and fifth ribs are resected in a similar fashion. Historically, this portion of the operation was performed as a second stage, but with modern advances in anesthetic and perioperative care, surgeons now complete the procedure in a single step. Progressively shorter segments of ribs 4 through 5, 6, or 7 are resected subperiosteally. The anterior border of resection of the fourth rib is the anterior axillary line, and the subsequent ribs are transected successfully posteriorly. A 5-rib thoracoplasty reduces the thoracic cavity by approximately 30%, but does not allow for scapular decent medially. Therefore, some surgeons advocate resecting the tip of the scapula in this scenario to avoid impingement on the sixth or seventh rib. A 7-rib thoracoplasty will allow for scapular collapse toward the mediastinum. The incision is closed in layers with absorbable suture, with no need for pleural drainage unless the pleural space has been violated during the procedure.
It is important to resect the ribs back to the transverse process and at times perhaps include some of the transverse process to obtain maximum collapse of the chest wall and to ensure complete obliteration of some large pleural cavities.
At this point, the surgeon dictates further extension of the operation according to the size of the cavity present. Before the advent of mechanical ventilation, surgeons would tend to limit the resection to the first 3 ribs because of the fear of excessive chest wall instability and ventilatory compromise. If a more extensive resection is planned, the fourth rib is divided posteriorly and at a point along the anterior axillary line. After this rib is resected, subsequent ribs are resected in progressively shorter segments anteriorly. This additional resection may be performed during the same operation or can be staged as a second procedure several weeks later, depending on the patient’s overall medical status and the amount of collapse achieved with this initial procedure. Up to 7 ribs can be resected; a 7-rib thoracoplasty leading to extensive collapse of the upper and mid-chest wall along with the underlying lung.
Resection of 5 ribs leads to an approximately a 25% collapse. A 7-rib thoracoplasty leads to approximately a 50% collapse of the chest wall, as shown in the above radiograph. Although such an extensive resection leads to significant chest wall deformity, adequate collapse of large, persistent pleural cavities can be achieved.
Most thoracoplastic procedures now are combined with myoplastic techniques that limit the extent of resection needed to obliterate the persistent space. Once an empyema has resolved with large-bore tube or open drainage, a persistent pleural space can be successfully obliterated by the interposition of skeletal muscle pedicles, closure of bronchopleural fistulas, and limited thoracoplasty. Myoplastic techniques have approximately a 75% success rate in cases of postresection and primary bronchopleural fistulas associated with tuberculosis. Even though the role of thoracoplasty has declined, this procedure, especially in combination with myoplastic techniques, will remain a viable option for treating the most persistent cavities complicating postresection empyemas.

REFERENCES


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