Manubrial-Clavicular-Chest Wall Explantation to Expose the Anterior Thoracic Inlet

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The anterior thoracic inlet is difficult to access surgically because of the overlying pectoral-shoulder girdle, clavicle, and manubrium. Two anterior approaches have been popularized by Dartevelle and colleagues [1] and by Grunenwald and Spaggiari [2]; however, with both techniques, retraction of an osteomuscular flap is required, and patients may be left with the functional and aesthetic implications of partial clavicular resection. We describe a novel technique involving manubrial-clavicular-chest wall explantation with preservation and reimplantation. Manubrial and clavicular plating is performed to stabilize the anterior chest wall and clavicle after reimplantation. This approach represents an alternative technique that provides excellent visualization of the entire anterior thoracic inlet.

Technique

After induction with a general anesthetic, the patient is placed in the supine position, with both arms tucked, a roll under the shoulders, and the head turned away from the operative side. An L-shaped incision is made along the anterior border of the sternocleidomastoid, extending in the midline onto the sternum, and tailing out laterally at the level of the third rib (Fig 1). A pectoralis major myocutaneous flap is mobilized off the chest wall from medial to lateral, and the sternocleidomastoid muscle is separated from the manubrium and clavicle (Fig 2). The manubrium and upper sternum are divided in the midline and laterally into the second or third rib space with a microsagittal saw. The internal mammary artery should be identified and ligated. A precontoured Synthes (West Chester, PA) locking compression plate is selected to allow maximal coverage of the shaft of the clavicle for fixation. Then the screw holes are predrilled in the clavicle according to the plate design. Performing this step before cutting the clavicle facilitates later reduction and internal fixation of the clavicle. Ideally, the plate is selected in a way to allow at least six cortices screw fixation on each side of the planned osteotomy. The plate is then removed, and a clavicular osteotomy is performed. The first and second ribs are divided laterally with a straight rib cutter, and the intercostal muscles are transected with electrocautery. The manubrial-clavicular-chest wall bloc is then dissected from the surrounding tissue and vascular structures, providing excellent exposure to the anterior thoracic inlet (Fig 3). The explanted manubrial-clavicular-chest wall specimen should be wrapped in a saline-soaked towel and stored on ice on the back table.

Once the anterior thoracic inlet tumor resection is complete, the clavicle is easily reduced and internally fixed by reinserting and tightening the predrilled screws through the plate into the clavicle. Special attention is directed toward compression of the osteotomy site during plate fixation. Combinations of modular locking plates and wires can used to stabilize the manubrium and

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sternum (Fig 4). With plate fixation of the sternum, manubrium, and clavicle, the chest wall is quite stable, making repair of the lateral ribs optional. A 28-Fr chest tube is positioned in the pleural space, and 2 No. 10 flat Jackson-Pratt drains are left between the chest wall and pectoralis major. The pectoralis major myocutaneous flap is used to cover the hardware anteriorly, and the sternocleidomastoid is sutured to the undersurface of the clavicle to separate the underlying vascular structures from the clavicular plate. The subcutaneous tissue and skin are reapproximated in the standard fashion.

Comment

Because the thoracic inlet is a small, rigid area surrounded by critical nervous and vascular structures, surgical treatment of tumors in this region presents a unique challenge. Manubrial-clavicular-chest wall explantation with preservation and reimplantation provides superb exposure to the cervicothoracic junction and allows safe en bloc resection of tumors. This technique also allows adequate access to hilar structures in the event that pulmonary resection is required. Alternatively, this technique can be combined with a thoracoscopic pulmonary resection. Unlike the anterior approaches popularized by Dartevelle and colleagues and by Gruenwald and Spaggiari, explantation of a portion of the chest wall obviates the need to retract an osteomuscular flap. This offers superb exposure for vascular resection, reconstruction, and preservation of critical nervous structures. Moreover, the postoperative morbidity of partial clavicular resection and disruption of the sternoclavicular joint are completely avoided.

We have performed this technique in 2 patients to date; 1 with an apical schwannoma and 1 with a recurrent typical carcinoid tumor in the apex of a postpneumonectomy space. Owing to the rigid plate reconstruction, both patients had early postoperative shoulder mobilization without functional deficit or aesthetic deformity. The only complication encountered was a delayed superficial wound infection requiring minor incision and drainage 3 months after the initial operation. There was no radiographic or clinical evidence of deep tissue infection, chest wall compromise, or hardware involvement.

Explantation, cryotherapy, and immediate reimplantation of autogenous sternum [3] and mandible [4] have been described in the treatment of primary and metastatic bone tumors. By use of this technique, sections of bone are explanted, devitalized with liquid nitrogen, and reimplanted as a matrix for cellular ingrowth. To our knowledge, this is the first report of reimplantation of an osteomuscular autogenous graft without microvascular anastomosis. Perfusion from the reapproximated sternal and rib marrow, combined with pectoralis myocutaneous flap coverage, may provide adequate blood flow to sustain the reimplanted specimen. Indeed, computed tomography scan demonstrated healing osteotomy sites and the presence of persistent intercostal musculature 3 months after operation in the earlier of the 2 patients.
Alternatively, the manubrial-clavicular-chest wall graft may simply act as a biologic scaffolding for cellular ingrowth. Our experience with this technique has not mandated removal of a reimplanted specimen for pathologic review; therefore, we can only speculate in this regard.

There are certain limitations to manubrial-clavicular-chest wall explantation with preservation and reimplantation. This approach cannot be used if the underlying tumor is invading the anterior chest wall at the level of the first or second ribs. Also, when considering the use of this technique, the surgeon must weigh the added expense of the sternal and clavicular plates and the possibility of future hardware infection against the improved exposure offered relative to other anterior approaches. Although we have had 7 months of clinical follow-up since the initial use of this technique, the long-term implications of manubrial-clavicular-chest wall explantation and reimplantation remain unknown. Finally, many patients who require surgical access to the thoracic inlet are treated with induction or consolidation chemotherapy and radiation. The feasibility of manubrial-clavicular-chest wall explantation with preservation and reimplantation in the setting of a multimodality approach remains to be determined. Despite this concern, the second of our 2 patients received 60 Gy of adjuvant radiation starting 6 weeks after the operation, without evidence of altered healing.

References