Anterior cervical vertebrectomy and interbody fusion

Technical note

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This report discusses the authors' technique in performing anterior cervical vertebrectomy and interbody fusion for multilevel cervical disease. The technique is performed with a high-speed drill and bone-bank fibular strut graft. After decompression of the cervical canal, ledges are made in the intact vertebral bodies to create a rectangular bed for safe seating of the bone graft. The bone-bank fibular strut graft is a feasible alternative to autograft. The simplified and safe nature of this procedure reduces postoperative morbidity as well as the length of hospital stay.

KEY WORDS • bone graft allograft • cervical spondylosis • vertebrectomy • interbody fusion • operative technique

Anterior cervical vertebrectomy with interbody fusion is one of the surgical procedures used for multilevel cervical disease, including cervical spondylosis and ossification of the posterior longitudinal ligament (OPLL). This report discusses our technique in performing this procedure using a high-speed drill and bone-bank fibular strut graft. This technique seeks to combine the relative safety of the Smith-Robinson operation with the improved exposure of the Cloward procedure. Its most frequent application is for multilevel cervical disease involving large posterior marginal osteophytes. Less common indications include OPLL and trauma. In addition, bone-bank allografts (used in our technique) represent a feasible alternative to autografts.

Operative Technique

Initial Dissection

After endotracheal intubation and induction of general anesthesia, the patient is placed in the supine position. The neck is mildly hyperextended by placing a roll under the shoulder blades. A Gardner-Wells tong is used for subsequent intraoperative traction in order to have a wide operative field. We prefer to operate from the patient's left side. An oblique skin incision is made along the anteromedial border of the left sternocleidomastoid muscle. The platysma is incised and undermined to improve the exposure. The anterior border of the sternocleidomastoid muscle is mobilized and the muscle retracted laterally. The dissection is continued medial to the carotid sheath. The omohyoid muscle crosses the operative field and is usually transected. The esophagus and trachea are retracted medially, and the carotid sheath is retracted laterally. The prevertebral fascia is then identified, cauterized, and incised to expose the anterior longitudinal ligament. The appropriate level is confirmed by an intraoperative lateral x-ray film of the cervical spine.

Discectomy

After confirmation of the level by x-ray film, dissection continues with at least partial removal of the discs at the rostral and caudal limits of the involved area. It is important to start with the discs for two reasons. The first is to gain a three-dimensional appreciation for the location of the spinal cord; otherwise, it is difficult to center the decompression over the anterior spinal dura. The other reason is that it is possible in cases with distorted anatomy, such as tumor, to leave behind a disc that should be removed. This can occur when dissection is begun in the middle of the vertebral body without first finding the disc space. The hard cortical bone at the inner border of the endplate can be mistaken for the outside of the neighboring vertebral body's endplate. This error results in an unstable construct which will fail since one end of the graft rests on a nonviable remnant of the cortical endplate, on the other
A. B.

FIG. I. Schematic diagram of the lateral cervical spine. A: Intact vertebral bodies, emphasizing the inferior angulation of the disc spaces. B: The extent of the osteotomy in our technique. C: The relationship of the fibular strut graft and the bone removal. The graft is actually slightly longer than the receptor site. Placement is facilitated by in-line skeletal traction at the moment of graft impaction. Also note the removal of the upper end of the lower intact vertebral body; this is important in eliminating the inferior angulation of the disc space and creating a rectangular bed.

Bone Dissection

Bone removal is accomplished with a high-speed drill. The shaft should be long enough to permit good visualization in the deepest part of the exposure, and the size of the bit appropriate to allow accurate sculpting of the bony central trench with its marginal ledges. The high speed of the drill promotes rapid dissection, but working with such a powerful tool of course entails significant risk. One ever-present danger is the potential for the drill bit to "skip" or "jump." To avoid spinal injury, it is important always to keep the shaft of the drill perpendicular to the dural surface. Another potential danger is the tendency for the drill to wrap up loose objects in the wound. All cottonoid pledgets should therefore be removed, and soft tissue not covered by blades of the self-retaining retractor should be protected with malleable retractors.

Drilling is continued to the posterior longitudinal ligament using loupe magnification and headlight illumination. The posterior longitudinal ligament is incised or drilled (if ossified) to expose the dura. There is no consensus regarding the handling of the posterior longitudinal ligament. Saunders, for example, recommends completely excising the ligament to achieve a good decompression, while others believe in preserving the ligament. We do not believe that it is necessary to completely excise the ligament. We do, however, open the ligament in the midline to be certain that the dura is decompressed. The osteophytes are removed with a drill attachment, enabling osteophytes at the extremes of the exposure to be removed with a slight angulation of the drill. The remaining disc material is also removed using standard techniques. Figure 1B shows the extent of the osteotomy in this procedure.

We decompress the ventral cervical cord by drilling a rectangular central trough through the center of the vertebral bodies with a width (12 mm) approximately equal to that obtained in a standard Smith-Robinson exposure (Fig. 2). In addition, we fashion a second rectangular trench ("fusion" rectangle) is fashioned slightly wider and longer but about 2 mm shallower than the first central trough, and is superimposed over the first one. In this way, the surgeon creates a marginal ledge upon which the bone graft can safely rest. Despite these ledges, it is possible to achieve a wide lateral decompression, especially at the disc levels. Significant osteophytes are usually at the disc level.

* High-speed drill and Model AM-8 attachment, manufactured by Midas Rex, Fort Worth, Texas.
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Fig. 3. Schematic drawing showing preparation of the bone-bank fibular strut graft. A: The graft is shaped with a high-speed drill. B: The bone graft is fashioned into an approximately rectangular contour to snugly fit the rectangular receptor site. C: The bone graft is beveled.

particularly at the lower end. These differences in shape are intended to discourage graft extrusion so it is important to keep them minimal. The best insurance against extrusion is an exact match in size and shape with the graft completely countersunk.

The length of the outer "fusion" (larger) rectangle is greater than the inner "decompression" (smaller) rectangle, particularly at the lower end (Fig. 2). This is dictated by the inferior angulation of the disc spaces of about 20° (Fig. 1A). After the lowest disc is removed, the superior vertebral endplate that is exposed presents a sloping surface, which could cause the graft to slide off and extrude. It is necessary to fashion a rectangular bed for the graft. Therefore, the drill is used to remove a portion of the upper end of the normal vertebral body (below the lowest removed disc) in the deep or posterior aspect of the fusion rectangle (Fig. 1C). This also creates more of a marginal ledge around the inferior part of the decompression rectangle (Fig. 2). This inferior shelf becomes useful when one impacts the graft. At the superior end of the fusion (larger) rectangle, the anterior lip of the inferior endplate of the next normal vertebral body (above the highest removed disc) is often too prominent. The temptation to preserve it is great, because it presents a surface that is naturally "undercut" due to the inferior angulation of the disc spaces. It is actually better to drill away some of this to make the fusion (larger) rectangle more of a rectangle and less of a parallelogram (Fig. 1B and C).

Bone Graft

Freeze-dried bone-bank fibular strut graft† is used for interbody fusion. The bone is recovered from a deceased donor under sterile procedures. The donor and the donated tissues are thoroughly tested and found negative for the major viral and bacterial antigens, antibodies, and species. No secondary sterilant such as ethylene oxide or irradiation is used. However, ethylene oxide-sterilized bone has been successfully used for interbody fusion (J Jackson, personal communication, 1991).14

The bone graft is preserved using lyophilization, which involves freezing the bone to ~70°C and removing the water sublimation.12 The bone is then sealed under vacuum in sterile glass containers using sterile stoppers and transported to the hospital. The bone graft is stored at room temperature and rehydrated prior to use.

After reconstitution, the bone-bank fibular strut graft (4 cm for one-level vertebrectomy, 6 cm for two-level vertebrectomy) is fashioned with a drill attachment in a rectangular shape to sit snugly in the prepared site (Figs. 3 and 4). It is important to fashion the fibular strut graft with a high-speed drill as rongeurs tend to shatter the brittle bone-bank bone.

Manual traction is applied by the anesthesiologist, and the bone graft is countersunk into position using an impactor and mallet (Figs. 4 and 5). The anesthesiologist then gently flexes the neck in order to observe the stability of the graft under direct vision, and bone dust, which had been collected during vertebral body resection, is placed over and around the bone graft.

Closure

The wound is irrigated with bacitracin solution. The platysma is closed with interrupted 3-0 Vicryl sutures, and the skin is closed with a running subcuticular 4-0 Dexon suture. The patient is placed in a hard cervical

† Banked bone provided by Osteotech, Inc., Shrewsbury, New Jersey.
B: The bone graft (slightly longer than the receptor site) is countersunk into position using an impactor and mallet. C: The graft countersunk in position.

(Philadelphia) collar and taken to the recovery room. As soon as recovery from the anesthesia is complete, the patient is allowed out of bed.

Discussion

Background

Anterior decompression and fusion operations have been performed since the 1950's, as described by Robinson and Smith,15,21 Southwick and Robinson,22 Bailey and Badgley,1 Cloward,4 Dereymaeker and Muller,3 Verbiest,23,24 and Simmons, et al.20 ("keystone" technique). These represent single-level decompression and fusion techniques (Fig. 6).

Anterior cervical vertebrectomy and corpectomy with interbody fusion is increasingly being performed to treat cervical spondylotic myelopathy.3,16,17 The decompression of the cervical canal in these procedures is more or less standard; however, there is some disagreement regarding the width of the decompression and the handling of the posterior longitudinal ligament.16,17 The greatest disagreement is in regard to the fusion techniques. One of the more popular techniques is notching the fibular strut graft, as described by Whitecloud and La Rocca25 (Fig. 6). Johnson and Southwick2 advocated carving keys on either end of the graft, which are fitted into "seating holes" or troughs drilled in the endplates of the upper and lower intact vertebral bodies (Fig. 6). This technique has also been described by other authors.18,19 Other methods of grafting include recessing the graft behind the anterior cortical margin of the vertebra,1,7,24 multilevel "keystone" technique,16,17 and using plates to improve fixation.3

Advantages of the Present Technique

Our anterior approach simplifies the vertebrectomy and interbody fusion while making it safer. Ledges are drilled to create a secure rectangular bed for the bone graft (Fig. 2). The ledges prevent the graft from injuring the ventral aspect of the spinal cord. The rectangular configuration of the graft and donor site with countersinking of the graft beneath the anterior surface of the spinal column prevents its extrusion. The present technique represents one possible method of making ledges; other modified methods can also be employed in making a similar construct (G Beach, personal communication, 1991).

The present technique employs a fibular allograft instead of an iliac crest or a fibular autograft. Its shape is more easily fashioned into a rectangular graft, and donor site-related pain is eliminated. Nevertheless, the choice of bone-bank fibular strut for bone grafting is controversial. It is believed that bone grafts containing no cancellous bone fuse slowly.8,13 Many investigators also find that banked bone is inferior to fresh autogenous bone for incorporation into a solid fusion.13 However, freeze-dried banked bone is readily available and is a feasible alternative to autogenous bone grafts. Freeze-dried allografts have been successfully used in clinical practice for many years,11,19 and the results obtained with freeze-dried banked bone have been comparable with those obtained from autografts.2,10,14,19

Our technique also minimizes the postoperative morbidity and the length of the hospital stay. Postoperatively, the patients are placed in a hard cervical collar, obviating the need for a halo vest. Morbidity associated with harvesting the autograft is avoided by using banked bone. Most patients undergoing this procedure have a short hospital stay; most of our patients were discharged within 5 days postoperatively. Patients with longer hospital stays required postoperative rehabilitation because of severe preoperative myelopathy.
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Between March, 1990, and September, 1990, seven patients have undergone anterior cervical vertebrectomy and interbody fusion using our technique. The results so far have been very good. There have been no postoperative neurological deficits or extrusions of the bone graft, and the mortality rate is 0%. In addition, postoperative diagnostic studies have revealed excellent positioning of the fibular strut grafts. Illustrative pre- and postoperative cervical magnetic resonance images are shown in Fig. 7. Clinical follow-up monitoring with objective assessment criteria is currently underway at our institution.

In summary, the technique described offers the following advantages: 1) spinal cord protection; 2) no donor site morbidity; 3) no halo immobilization; and 4) a short hospital stay.

References

Manuscript received February 21, 1991.
Accepted in final form May 29, 1991.
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