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Use of cylindrical titanium mesh and locking plates in anterior cervical fusion

Technical note

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After performing anterior cervical corpectomy or discectomy for cervical spondolytic myelopathy or radiculopathy, iliac crest bone graft and fibular auto- or allograft is often used to achieve arthrodesis in the cervical spine. The purpose of this study was to evaluate the use of a cylindrical titanium mesh and locking plate system as an alternative technique in achieving anterior cervical fusion and maintaining lordosis.

Hospital records and radiographs of 38 patients who underwent anterior cervical discectomies (28 patients) or corpectomies (10 patients) from 1995 to 1997 were reviewed retrospectively. All patients had undergone arthrodesis in which autograft and a cylindrical titanium mesh and anterior locking plate fixation were used after discectomy or corpectomy. There were 20 men and 18 women (mean age 46.1 years; range 34–72 years). Presenting symptoms included radiculopathy (61%), myelopathy (37%), and neck pain (2%). Preoperative and postoperative radiographs were studied, and data were obtained on the following: overall lordosis or kyphosis of the cervical spine, segmental lordosis or kyphosis at each surgically treated level, and evidence of fusion.

In all of the patients in whom lordosis was present preoperatively, lordosis was maintained during the follow-up period. The overall fusion rate was 100%. The average change in overall lordosis or kyphosis related to the fixation devices was 1.2° (range 1–5°); the average segmental change was 2.3° (range 0–5°); and the mean follow up was 16 months (range 12–36 months).

Anterior cervical fusion with cylindrical titanium mesh and cervical locking plate system is an effective method of achieving arthrodesis and maintaining alignment in the cervical spine. The construct may provide additional load-sharing function, and it avoids the use of cadaveric bone or the need for harvesting tricortical iliac crest autograft.

Key Words • **anterior cervical fusion** • **cylindrical titanium mesh** • **lordosis**

Anterior cervical fusion historically has been used for the treatment of various degenerative diseases of the cervical spine and instability secondary to trauma or infection. It is most commonly performed after removal of herniated discs, osteophytes, or after corpectomy. In traditional methods of fusion surgeons have used iliac crest autograft or cadaveric iliac crest or fibula placed between the endplates.[3,15,16] Recently some authors have advocated the addition of locking plates to reduce the incidence of graft dislodgment, to maintain cervical lordosis, and to improve the rate of arthrodesis.[5,8,10,17] Screw loosening, screw backout, and breakage of screws or plates remain clinical hardware-related complications that warrant concern. These complications are believed in part to be caused by bone resorption during fusion; this process leads to graft collapse, which places an increased bending moment at the screw–plate interface and precipitates fatigue and subsequent failure of the construct. We present our experience with a surgical technique for arthrodesis in the cervical spine; we describe the use of local autologous bone to fill a cylindrical titanium mesh that is placed in combination with a locking plate. We believe this technique avoids the morbidity associated with harvesting a tricorticale iliac crest autograft while producing a construct with additional load-sharing function, which may help maintain cervical lordosis. The surgical technique and results in 38 patients with a minimum follow-up period of 1 year are reviewed.

Abbreviation used in this manuscript: VB = vertebral body.

Clinical Material and Methods

Patient Population

We retrospectively reviewed the hospital records and radiographs of 38 patients who, between 1995 and 1997,

underwent anterior cervical discectomies (28 patients) or corpectomies (10 patients) followed by placement of autograft and a cylindrical titanium mesh and anterior locking plate system. There were 20 men and 18 women (mean age 46.1 years; range 34–72 years). Presenting symptoms included radiculopathy (61%), myelopathy (37%), and neck pain (2%). The cause of the symptoms was degenerative disc disease in 34 patients (94%), traumatic injury in two patients (4%), osteomyelitis in one patient (2%), and pseudarthrosis after a prior attempt at cervical fusion in one patient (2%). Thirteen (34%) of the 38 patients were smokers. Twenty-eight patients underwent discectomies (16 one-level and 12 two-level procedures). Ten patients underwent corpectomies (two one-level, seven two-level, and one three-level).

Description of Surgical Technique

All the patients underwent surgery in the supine position with the neck slightly extended or neutral. Either Holter traction or tongs are placed prior to making the skin incision. A transverse skin incision is used for one- or two-level fusions, and a vertical incision along the sternocleidomastoid is used when three- or four-level fusions are conducted. After performing the anterior cervical discectomy or corpectomy, the endplates are burred with a high-speed drill until punctate bleeding is seen from the subchondral bone.

Autogenous cancellous bone is harvested from local VBs for the corpectomies (Fig. 1). In cases in which the local bone was diseased or insufficient, cancellous autograft is harvested through a 2-cm incision over the iliac crest: a small window is made in the cortical bone by using an osteotome and the cancellous bone is removed using curettes. At this point manual traction is gently applied for distraction, and all dimensions of the space are carefully measured so that the titanium mesh can be cut to the appropriate height. Various widths of mesh are available so they can be tailored to each patient. The cylindrical mesh is then packed tightly with the autologous bone, tamped into the space, and recessed 2 to 3 mm below the anterior border of the VBs. The remainder of the bone is then packed around and in front of the mesh. The traction device is then removed, and the neck is returned to a neutral position so that the construct may be compressed. The anterior locking plate and screws are then placed across the segments to be fused. After intraoperative radiography to confirm correct placement of the construct is performed, the locking screws are placed, and the platysma is reapproximated using No. 3-0 absorbable sutures and the skin is closed with No. 4-0 subcuticular sutures. No drain is used. The patient wears a soft cervical collar postoperatively for 1 week.

Radiographic Evaluation

Preoperative and postoperative radiographs are obtained to assess cervical alignment immediately after surgery and then at 3, 6, and 12 months postoperatively and annually thereafter (Fig. 2). The overall lordosis or kyphosis was measured in degrees by using the Cobb angle between each endplate at the cranial and caudal end of the fused segments (overall lordosis or kyphosis) (Fig. 3 *upper*). In addition, the segmental lordosis or kyphosis at each level was measured across each disc space or VB within the fused segment (Fig. 3 *lower*).

Results

In 30 patients the spines were lordotic, in two they were neutral, and in six they were kyphotic. All of the spines that were lordotic or neutral preoperatively remained so during the follow-up period. Postoperatively the patients underwent plain radiographic follow-up evaluation imme-

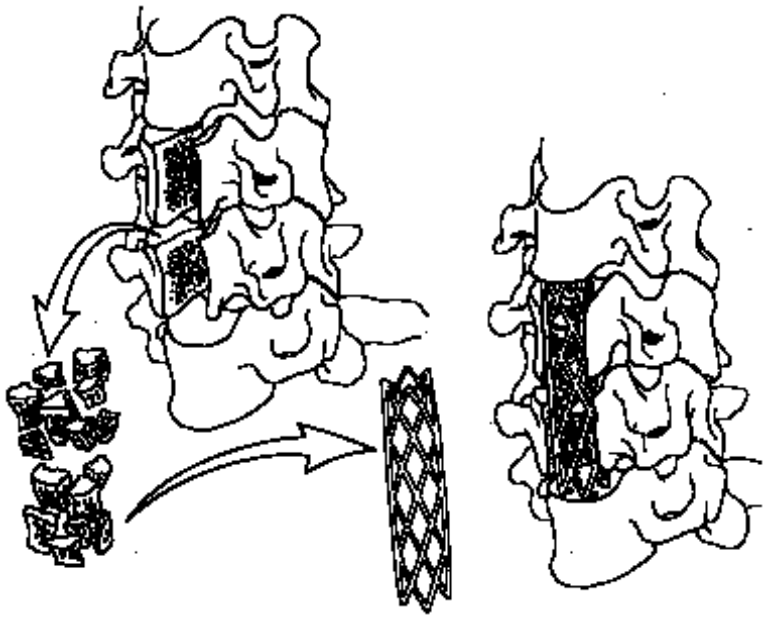

FIG. 1. Illustration of the technique. Morselized local bone from corpectomy is used to fill the cylindrical titanium mesh.

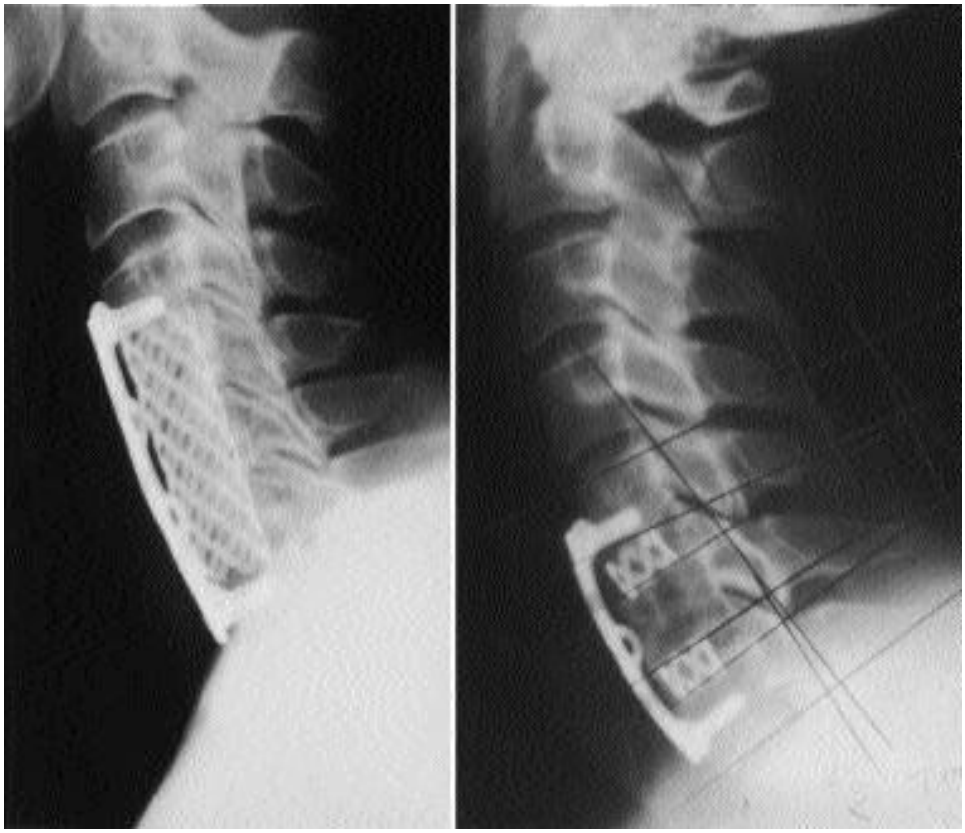

FIG. 2. Postoperative radiographs demonstrating the cage and locking plate system after a three-level corpectomy *(left)*, and two-level discectomy *(right)*.

diately postoperatively, at 3, 6, and 12 months postoperatively, and every 12 months thereafter. The change in overall and segmental alignment was calculated by subtracting the degrees of lordosis or kyphosis at 0 months (immediately postoperatively) from the degrees of lordosis or kyphosis demonstrated on the last postoperative radiograph. The results obtained from the follow-up radiographs are illustrated in Table 1.

The minimum follow-up duration was 1 year, the range was 12 to 36 months, and the mean duration was 16 months. During this period there were no cases of instrumentation failure (screw backout or plate breakage). The analysis of postoperative radiographs of cylindrical titanium mesh is difficult. Because of this difficulty, the true radiography-based definition of a solid arthrodesis in these cases is debatable. We defined fusion based on the presence of all of the following radiographic features: the absence of lucencies or halo formation around the screws or cage–bone interface; the absence of screw backout or plate breakage or migration; and bone growth visualized around or in the cage. Based on this definition, successful fusion was achieved in all cases (100%).

Discussion

Robinson and Smith[15] originally introduced anterior cervical fusion in 1955. There are several advantages of fusing the cervical spine when treating degenerative disease. One potential advantage is the prevention of formation of new osteophytes after decompression (spurs already formed may regress after stability of the fusion mass). Another benefit is distraction of the disc space, which may prevent buckling of the ligamentum flavum and increase neural foramen volume, resulting in decompression of the nerve roots. Over the years a number of modifications of the type of graft used have been made, including the dowel graft developed by Cloward,[3] the iliac strut graft used by Bailey and Badgley,[1] and the keystone graft of Simmons and Bhalla.[19] All of these techniques have been used successfully to fuse the cervical spine. In most of the series the authors reported high clinical success rate, with 80% or more achieving a pseudarthrosis rate as low as 6 to 8% for one-level disease.[13,14] However, when treating multiple levels the outcome was not as good, and the pseudarthrosis rate was inversely proportional to the number of levels fused and has been reported to be as high as 15 to 46%.[4,22]

In several recent studies the authors have demonstrated that the addition of an anterior plate may help in reducing the graft-related complication,[5,8,12,18] maintain cervical lordosis,[10] and may even shorten the period of recumbence. However, there is still a significant incidence of plate breakage or migration and screw backout, which warrants concern.[2,6,20,23] These complications are believed in part due to bone resorption during fusion; this can lead to graft collapse which, in turn, places an increased bending moment at the screw plate interface and leads to implant fatigue and subsequent failure. There is also an increased morbidity related to the harvesting an iliac crest tricortical

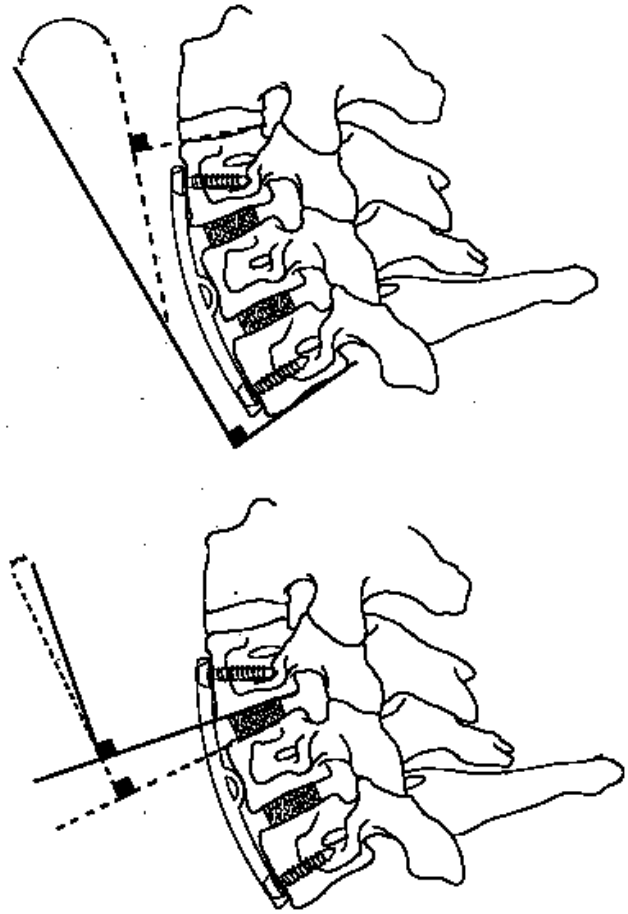

FIG. 3. Illustrations of how the angles are measured for both overall *(upper)* and segmental *(lower)* lordosis or kyphosis.

or bone dowel graft, which may increase the patient's recovery time. As a result of this, some surgeons have used cadaver allograft with or without a locking plate and have reported excellent results.[7,17,18,21,24]

We used cylindrical titanium mesh and a locking plate system for anterior cervical fusion as an alternative to traditional grafts (iliac crest autograft, iliac crest, and fibula allograft). Cylindrical titanium mesh has been used in the thoracic and lumbar spine for anterior column support after vertebrectomy. Biomechanical studies in the thoracolumbar spine have demonstrated that when compared with iliac crest, humerus, and ribs, mesh provided the greatest amount of resistance to axial loading.[9] We hypothesized that the addition of the cage in the cervical spine may act as a load-sharing device and help maintain cervical lordosis, thus leading to a reduction in stress at the screw–plate interface. The cage also allows the use of local bone as the graft when performing corpectomies. In the remainder of cases cancellous autograft can be harvested through a small incision or by using percutaneous techniques, both of which require less soft tissue exposure than harvesting tricortical iliac crest or dowel graft.

Our results indicate that in all patients with lordotic spines, this status was maintained during the follow-up period. There were no cases of construct failure during the follow-up period. There was a minimal amount of subsidence that resulted in a 1 to 2˚ loss of lordosis or increase in kyphosis observed in nearly all cases, which occurred within the first 3 to 6 months postoperatively. In the patients who were followed for more than 12 months this change remained stable. A longer follow-up period is necessary to determine if the cages significantly maintain lordosis, and follow-up results should be compared with those reported for traditional methods.

Conclusions

As also recently reported by others,[11] anterior cervical arthrodesis with cylindrical titanium mesh is a safe and effective alternative means of fusing the cervical spine following discectomy or corpectomy. The cages, used in conjunction with an anterior plate system, provide immediate strong anterior column support. This technique offers the advantages of using local autologous graft and a construct with excellent load-sharing capacity, and it may be used in multilevel reconstructions in which shortcomings of other techniques exist. During the follow-up period in the present study, it also appeared to maintain cervical lordosis.

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TABLE 1

Overall and segmental alignment of the fused segments as determined on immediate postoperative and follow-up x-rays after 12 to 36 months

		Immediate Postop		Last Follow Up			
	No. of Patients	Avg	Range	Avg	Range	Avg Change	Range
overall alignment							
lordosis	30	8.3˚	1–15˚	7.1˚	1–12˚	1.2˚	1–5˚
neutral	2	0˚	0˚	0˚	0˚	—	—
kyphosis	6	8.7˚	3–27˚	8.9˚	3–27˚	0.2˚	0–1˚
segmental alignment*							
lordosis	26	4.1˚	1–7˚	1.8˚	1–7˚	2.3˚	0–5˚
neutral	8	0˚	0˚	0˚	0˚	—	—
kyphosis	6	4.2˚	2–15˚	4.4˚	2–15˚	0.2˚	0–1˚

* Values for segmental alignment reflect the number of vertebral levels fused. Abbreviation: Avg = average.

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