Single-stage anterior–posterior decompression and stabilization for complex cervical spine disorders

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Object. To evaluate the applicability and safety of single-stage combined anterior–posterior decompression and fusion for complex cervical spine disorders, the authors retrospectively reviewed 72 consecutive procedures of this type performed at their respective institutions.

Methods. The indications for decompression and stabilization included: postlaminectomy kyphosis (15 patients), trauma (19 patients), spondylosis and congenital stenosis (32 patients), and ossification of the posterior longitudinal ligament (six patients). All patients underwent anterior cervical corpectomies in which allograft fibula and plates were placed, with 89% of patients undergoing two- or three-level procedures (range one–four levels). Lateral mass plating with autograft (morselized iliac crest) fusion was performed in all patients while the same anesthetic agent was still in effect. A hard cervical collar was used postoperatively in all patients (mean 13 weeks). All patients were followed for a minimum of 2 years (mean 29 months).

Fusion was determined to be successful in all 72 patients (100%). Although the short-term morbidity rate reached 32%, the significant long-term morbidity rate was only 5%. At the 2-year follow-up examination, anterior cervical plate dislodgment was seen in one patient, and 16 of the 516 lateral mass screws implanted were observed to have partially backed out. However, there were no cases of nerve root injury, strut graft extrusion, or anterior plate or screw fracture. There were no clinically significant hardware complications and no patient required repeated operation.

Conclusions. The combined single-stage anterior–posterior decompression, reconstruction, and instrumentation procedure represents a viable option in the treatment of a select group of patients with complex cervical spinal disorders. The technique provides immediate rigid stabilization of the cervical spine, prevents anterior plate failure or strut graft extrusion, and eliminates the need for halo immobilization postoperatively. Furthermore, a higher rate of fusion is achieved with this combined approach than with the anterior approach alone.

KEY WORDS • cervical spondylosis • cervical spine trauma • spinal instrumentation • cervical spine fusion

During the past decade there has been a growing interest in the management of complex cervical spine disorders. A better understanding of the biomechanics involved in both normal and pathological conditions of the cervical spine,^{2,13,34} as well as the introduction and successful application of innovative spinal instrumentation,^{1,4,28,31,35, 40,44,51} have paved the way for an aggressive surgical approach to these disorders. The purpose of this study was to evaluate the applicability, safety, and radiographically observed efficacy of a combined single-stage anterior–posterior approach involving decompression, reconstruction, and stabilization procedures in select patients suffering from complex cervical spine disorders.

Abbreviations used in this paper: OPLL = ossification of the posterior longitudinal ligament.

Controversy continues to surround the most effective method for decompression, reconstruction, and stabilization of complex cervical spine disorders such as traumatic instability, postlaminectomy kyphosis, multilevel spondylosis, and OPLL. Although it is becoming increasingly clear that anterior plating for single-level corpectomies enhances arthrodesis and diminishes graft extrusion,^{7,22,24, 28,47,56} the effectiveness of anterior plating in decreasing graft dislodgment or promoting fusion in multilevel corpectomies is less clear.^{33,45,57} Posterior decompressive approaches without placement of instrumentation are indicated in patients with multisegmental stenosis (for example, congenital or degenerative disease) with preserved lordosis.^{16,30,50,57} Decompressive laminectomy with instrumentation is used in the presence of frank instability or loss of lordosis (such as in a straight cervical spine) to prevent late kyphotic deformity (unpublished data, Gropper, et al., 1998).

TABLE 1

Number of vertebral segments resected

Segment	No. of Patients
one	6
two	34
three	30
four	2

TABLE 2

Indications for procedure in 72 patients

Diagnosis	No. of Patients (%)
trauma	19 (26)
postlaminectomy kyphosis	15 (21)
multilevel cervical spondylosis & congenital stenosis	32 (44)
OPLL	6 (8)

In the presence of a kyphotic deformity requiring multilevel vertebrectomies, anterior reconstruction with plates and simple (nonhalo) bracing may not be the optimum treatment. When confronted with this clinical picture, a combined anterior-posterior approach may yield a very high fusion rate with few graft- or plate-related complications. In the literature, however, there are few reports of experience with a single-stage combined anterior-posterior approach.^{37,38,51} To evaluate its applicability, safety, and efficacy, we reviewed outcomes in 78 patients with complex cervical spinal disorders treated with this combined approach.

CLINICAL MATERIAL AND METHODS

Patient Population

From October 1989 through October 1997 a total of 78 patients (42 men and 30 women, mean age 53 years [range 33–73 years]) underwent a single-stage procedure involving anterior subtotal removal of one or more vertebral bodies, fibular allograft strut graft placement, and anterior plating and posterior fusion, with and without decompression. With six patients lost to follow up, we performed a retrospective review of the remaining 72 patients followed for a minimum of 2 years (mean follow-up period 29 months). Eighty-nine percent of the patients underwent two- or three-level vertebral body resections (range one–four levels; Table 1).

The pathological conditions treated by the surgical procedure are outlined in Table 2. Nineteen patients presented with traumatic instability and kyphotic deformity; all of these patients sustained a distractive flexion, flexion-compression, or burst fracture of at least one vertebral body associated with posterior ligamentous disruption. Sixteen patients were treated acutely, and three patients presented with subacute instability. All patients demonstrated significant kyphotic deformities with both ventral and dorsal spinal cord compression and either overt (in cases of trauma) or glacial multicolumn instability.

Fifteen patients presented with delayed postlaminectomy kyphosis associated with progressive neurological deterioration. Thirty-two patients presented with multilevel cervical spondylosis ($\geq$ two levels) associated with congenital stenosis, and six patients presented with OPLL. Significant anterior disease was observed in all of the patients in these last two groups, along with loss of normal cervical lordosis and/or other complicating factors such as poor bone quality due to osteoporosis, tobacco use, or diabetes.

Surgical Technique

Patients were placed supine with a small roll placed

horizontally beneath the shoulders. Neck flexion and extension were assessed preoperatively to ascertain optimum patient positioning. Somatosensory evoked potentials were used only if a significant reduction in deformity was anticipated. Antibiotic medications (typically a first-generation cephalosporin but occasionally broader-spectrum coverage in chronically ill patients) were administered intravenously on the patient's arrival in the operating room. In patients with gross instability or in whom hyperextension was contraindicated, fiberoptic intubation was performed. Otherwise standard endotracheal intubation was performed via direct laryngoscopy.

A standard anterior approach to the cervical spine was used as the first stage of the procedure. Exposure was limited to one vertebral body above and below the vertebral body or bodies to be excised. Routinely the omohyoid muscle was transected, and careful wide dissection of the plane between the midline trachea and esophagus from the lateral carotid sheath was performed to allow for a relaxed exposure. Discectomies and corpectomies were then performed at the appropriate levels to a width of approximately 15 mm. Distraction pins (Caspar; Aesculap, San Francisco, CA) were positioned and a fibular allograft was fashioned as a strut graft. To aid in reduction, these vertebral body pins were occasionally placed divergently in a rostrocaudal fashion. Combined with manual manipulation, the distraction afforded by this method allowed for proper sagittal realignment of the spine. After fashioning a fibular strut allograft to the appropriate length, the center of the graft was filled with autograft cancellous bone harvested from the resected vertebral bodies. During distraction, the graft was placed within the corpectomy defect.

Once reconstruction was completed, the distraction pins were removed and an anterior cervical plate was positioned. During the course of the study, our preferences in anterior plate systems evolved. A total of 11 Synthes (Paoli, PA) cervical spine locking plates and 18 Orion (Sofamor-Danek, Memphis, TN) and 43 Codman (Randolph, MA) anterior cervical plates were used. After the plates were positioned, a single intraoperative cross-table radiograph was obtained to confirm placement of the graft and instrumentation. The wound was closed in layers over a closed suction system.

With the patient's head held in a neutral position and a Mayfield three-point head holder applied, the patient was positioned prone and the head holder was fastened to the operative table. A midline cervical skin incision was made, followed by a subperiosteal dissection to expose the lateral masses of the affected levels; exposure was confirmed by means of a cross-table lateral plain x-ray film when needed. In 18 patients who required additional pos-

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Fig. 1. Lateral plain x-ray films of the cervical spine obtained in the neutral (*left*), extended (*center*), and flexed (*right*) positions in a patient 4 years after C4–6 corpectomy in which C3–7 fixation was performed using fibular strut allograft and a cervical plate combined with placement of a posterior lateral mass plate from C-3 to C-7. Note osseous integration of the fibular strut graft anteriorly and opacification of the facet joints posteriorly. There is no evidence of movement or hypermobility of the adjacent nonfused level; however, some early sclerotic changes are evident in the C2–3 joint.

terior decompression, laminectomies were performed. Posterior stabilization was accomplished by placing lateral mass plates. Before the plates were screwed into position, cancellous autograft obtained from the posterior iliac crest was packed into the decorticated facet joints. In general, posterior fusion was confined to the decompressed levels or, when decompression was not performed, to the levels fused anteriorly. Occasionally, the posterior construct was carried in a more rostral and/or caudal direction, depending on the perceived stability of the intraoperative construct. (We consider incorporating the T-1 level with transpedicular screws when a multilevel stabilization procedure produces a long lever arm at the cervicothoracic junction. Arthrodesis across this transitional segment may prevent the instability seen at the cervicothoracic junction during long-term follow up.) The posterior wound was closed using closed suction in a standard fashion. A rigid cervical collar was applied. Finally, the patient was returned to the supine position and extubated.

Patients were ambulatory on postoperative Day 1 and cervical collars were worn for 12 to 18 weeks (mean 13.1 weeks). No halo vest orthosis was used in this series. Stability was assessed on lateral radiographs with flexion-extension views at 3, 6, and 12 months and then yearly thereafter. Fusion was deemed solid when bridging osseous trabeculae were seen between the graft and adjacent vertebral bodies anteriorly and facet opacification was present posteriorly. No movement observed on dynamic films also supported the diagnosis of solid fusion. In cases in which the caudal aspect of the fusion extended to C-7 or T-1 and the graft-vertebrae interface was obscured by the shoulders, lateral radiography further aided our assessment of fusion.

RESULTS

Operative Data

In this series, the average total operative time was 6.4

hours and the average blood loss was 470 ml. There were no perioperative airway complications necessitating emergency tracheostomy or reintubation. Although no wound infections were encountered at the cervical surgical sites, two graft harvest-site infections were documented; these are discussed later in this paper.

Neurological Results

Immediately postoperatively, there were two patients who developed new neurological deficits. Both patients were treated for OPLL and awakened with a worsening of their myelopathy. In both individuals, the OPLL had been dissected from the anterior portion of the spinal cord, which most likely accounted for their new deficits. Fortunately the deficits were transient, and at long-term follow up, both had demonstrated improvement over their preoperative status. All remaining patients similarly demonstrated subjective and objective neurological improvement in both spinal cord and nerve root function at long-term follow up. No patient suffered neurological deterioration related to instrumentation placement.

Radiographically Documented Stability

At the latest follow-up examination (> 2 years), sagittal alignment, as compared with immediate postoperative radiographic alignment, was seen to have been maintained in all but one patient (see *Surgical Complications*). Furthermore, no significant movement was observed across the fused level(s). Evidence of anterior fusion was observed on radiographic studies in all patients (Fig. 1). Although difficult to see in all cases because of the radiographic technique used, facet opacification was apparent in most patients. Anecdotally, when we compared the radiographic studies obtained in patients 3 months postoperatively with those in patients treated using only an anterior procedure, it appeared that the allograft fibular strut

TABLE 3
Procedure-related complications

Complication	No. of Patients
transient	
worsening of myelopathy	2
cerebrospinal fluid leak (OPLL)	1
dysphagia	6
hoarseness	12
graft harvest site infection	2
permanent	
dysphagia (partial)	1
superior laryngeal nerve injury	1
graft harvest site pain	2

incorporated into the adjacent vertebral levels more quickly in those who underwent combined anterior-posterior stabilization.

Surgical Complications

The immediately postoperative and long-term complication rates are listed in Table 3. Although the immediate complication rate was high (32%), most problems were transient, yielding a long-term complication rate of only 5%. Almost all of these complications were related to the anterior portion of the procedure.

Transient neurological worsening, as noted earlier, occurred in two of the 72 patients, both of whom had OPLL. One of these patients, whose dura was calcified and subsequently removed along with the OPLL, suffered a cerebrospinal fluid leak intraoperatively. The dural defect was covered with Gelfoam (Upjohn, Kalamazoo, MI), and the bone graft was positioned. The patient recovered without additional sequelae; use of a lumbar drain was not required.

Six patients (8.3%) experienced new difficulty swallowing immediately postoperatively. In two (2.7%) of these patients, the dysphagia did not improve to baseline levels. One of these individuals suffered significant dysphagia preoperatively and ultimately required a gastrostomy for long-term feeding.

New postoperative hoarseness was found to be transient in seven individuals (10%) and permanent in one (1.4%). The latter patient appeared to have suffered a superior laryngeal nerve injury characterized by voice fatigue.

For the combined procedures we generally use a very small window into the posterior iliac crest to harvest cancellous bone. It has been our experience that patients tend to experience less graft-related site pain if the gluteus musculature is not dissected from the ileum. However, two patients (2.7%) sustained superficial posterior iliac crest wounds requiring bedside debridement, packing, and a short course of oral antibiotic treatment. The wounds in both patients went on to heal without further difficulty. In addition, two other patients (2.7%) complained of chronic posterior iliac crest discomfort.

The patients in this series suffered no clinically significant complications related to the hardware or the allograft strut. Specifically, there were no plate or screw fractures anteriorly or posteriorly and no cases of graft extrusion. Anteriorly, one cervical plate (1.4%) pulled out due to a

slip of the rostral screws. Although the patient lost some of the sagittal alignment demonstrated immediately postoperative, his cervical spine went on to fuse anteriorly without further intervention. Sixteen (3.1%) of 516 lateral mass screws placed partially backed out. Clinically, however, the patients were asymptomatic and no posterior construct required a revision.

DISCUSSION

The most effective method for decompression, reconstruction, and stabilization of patients with complex cervical spine disorders remains controversial. Although many authors have reported satisfactory results by using either the anterior and posterior approach alone, graft dislodgment, plate failure, pseudarthrosis, progressive kyphotic deformities, and halo vest-related complications remain significant concerns. We also believe that most degenerative cervical disorders can be addressed surgically with an isolated anterior or posterior approach. However, the patients presented in this study represent a subpopulation with more complex disorders of the spine resulting from multilevel degenerative disease (spondylosis and OPLL), severe postsurgical deformity, or trauma. Although the mechanisms of instability are quite different in these groups of patients, the common pathological entity is the presence of multicolumn instability.

The literature regarding the management of these more complex cervical spinal disorders is far from conclusive. Various methods of reconstruction have been proposed, including anterior, posterior, and combined approaches, using a variety of internal fixation devices and postoperative orthoses.^{4,7,16,18,19,22-25,27-30,33,42,47,56,57} Our approach has been to treat these patients with a combined anterior-posterior procedure that allows for decompression and restoration of sagittal alignment while providing immediate stability without the need for halo bracing.

Indications for Combined Anterior-Posterior Approach

Vertebral Spine Trauma. In cases of acute trauma resulting in bicombar failure, the high incidence of pseudarthroses associated with a single approach has led several authors to state that spinal instability this severe requires combined anterior-posterior stabilization.^{1,9,12,18,37,38,50,57} Injury patterns include flexion-compression, burst fracture, and flexion-distraction injuries to the vertebral bodies, as described by Allen, et al.,² Cybulski, et al.,¹² have reported good results with anterior decompression, fusion, plating, and halo immobilization in cases of overt traumatic instability; they cite reduced patient morbidity and complication rates compared with those associated with combined anterior-posterior procedures. In contrast, we have found that the single-stage anterior-posterior approach allows us directly to address the diseased segments and immediately restore stability to the cervical spine with an acceptable long-term complication rate (5%). Furthermore, although some authors prefer using a halo after a combined procedure,³⁸ we have found that a simple hard cervical collar is adequate; we have thus avoided the well-documented complications associated with halo use.^{6,20,53} This allows for easier mobilization and rehabilitation of

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patients, an advantage that can be critical for the recovery of patients suffering multisystem trauma.

Postlaminectomy Cervical Kyphosis and Myelopathy. The development of a "swan-neck" deformity secondary to multilevel laminectomies has been well described in both the pediatric and adult populations, with frequencies as high as 50%³² and 3 to 14%,^{39,48} respectively. The techniques and success of salvage operations vary. Preoperative external traction with posterior fixation alone and anterior decompression and fusion with or without anterior cervical plating and halo immobilization, as well as combined anterior-posterior procedures, have all been proposed.^{24,48,57}

Unlike children who more commonly develop a symptomatic kyphotic deformity soon after an extensive laminectomy, adults often have a more long-standing deformity with associated osteophytic overgrowth. The authors of a recent study²⁴ found that preoperative traction produced a mean reduction of only 8° in 20 adult patients with postlaminectomy kyphosis. In view of these findings, attempts at reduction and subsequent posterior fusion may be more successful in children than in adults. An anterior approach allows better intraoperative correction of kyphosis by removing restrictive elements such as osteophytes and the joints of Luschka. However, in the presence of an incompetent posterior tension band (such as in cases of trauma or previous laminectomy), experience with anterior decompression and reconstruction alone has been associated with graft complications (displacement and/or fracture) and postoperative instability ranging between 19% and 100% in selected series.^{50,55,57} To avoid these graft-related problems, the use of rigid internal fixation with various anterior cervical plating systems has become common.

Both Johnston and Crockard²⁸ and Herman and Sonntag²⁴ have reported results of multilevel cervical corpectomies, fusion, and anterior cervical plating for postlaminectomy kyphosis: the investigators were able to achieve kyphosis reduction and fusion in all patients, using halo immobilization in only select patients. Symptomatic instrumentation failures were reported to be 4% and 5% in patients with and without halo immobilization, respectively.

We have also achieved good results with the use of anterior decompression, fusion, and plate osteosynthesis in patients with postlaminectomy kyphosis. Although we have achieved arthrodesis in approximately 92% of selected patients (unpublished data, Martin, et al., and Mayer, et al., 1998), we have reserved this approach for individuals with good bone quality requiring one- or two-level vertebrectomies who have minimal posterior column disease (as demonstrated on dynamic flexion-extension films). We strongly consider a combined approach in patients with a severe, mobile kyphotic deformity requiring decompression of three vertebral levels or more. In addition, we also consider patients with less severe kyphotic deformities (that is, with fewer spinal segments involved) as candidates for a combined approach if they also suffer from comorbid conditions affecting bone quality, including smoking, diabetes, osteoporosis, and renal dialysis. By providing rigid internal fixation to both the

anterior and posterior columns, we have increased our fusion rates while significantly reducing graft and instrumentation failures in the immediately perioperative period.

Multilevel Cervical Spondylosis and OPLL. Opinions continue to differ regarding the most effective procedure for treating multilevel degenerative disease. Retrospective outcome studies have reported equivalent²⁷ or slightly improved outcomes^{7,56} when comparing anterior with posterior procedures. A posterior approach with a simple laminectomy^{8,11,14,15,17,21,36,41,46} or laminoplasty^{26,52} has been advocated by many authors, including ourselves, who believe that this procedure yields a lower morbidity rate and is better tolerated by elderly patients. Late loss of neurological function following laminectomy secondary to progressive instability, late kyphotic deformity, and continued anterior compression is well documented and has been estimated to occur in 19 to 53% of patients.^{29,54} However, it is difficult to predict which patients are at risk for this complication. Gropper, et al., (unpublished data, 1998), have demonstrated an increased incidence of postlaminectomy kyphosis in patients whose cervical spines were found to be straight or kyphotic preoperatively, and they concluded that these patients should be considered for a simultaneous posterior fusion.

Since the introduction of anterior approaches to the cervical spine by Bailey and Badgley,⁵ Smith and Robinson,⁴⁹ and Cloward,¹⁰ multilevel discectomy and interbody fusion procedures have been used effectively for cervical spondylotic myelopathy.^{10,11,21,43} However, the reduced fusion rates obtained when this procedure is performed over multiple segments and the lack of adequate decompression in cases of OPLL and spondylosis have led to the use of partial vertebrectomy followed by stabilization with iliac crest or fibular struts.^{7,22,30,42,45,56} This procedure allows for wide removal of compressive elements over numerous motion segments and prevents progression of kyphosis in the majority of patients.

A major cause of morbidity associated with multilevel anterior decompressions, however, is malformation of the structural graft. A 5 to 14% incidence of strut graft dislodgement^{30,33,42,45,56,57} and a 0 to 41% nonunion rate^{16,19,23,30} have been reported when strut grafts are used alone to treat multilevel degenerative disease, even with use of halo immobilization. Anterior cervical plating has been used effectively to improve fusion and reduce graft failure rates after multilevel corpectomies (unpublished data, Martin, et al., and Mayer, et al., 1998). Nevertheless, graft dislocation still occurs in 6 to 10% of patients (unpublished data, Foley, et al., and Rhoten, et al., 1997).

In the current series, we treated 38 patients with multilevel degenerative disc disease (involvement of ≥ 3 disc spaces) or OPLL. In addition to significant anterior compression from the osteocartilaginous spur or OPLL, a loss of lordosis with either straightening or frank kyphosis of the cervical spine was observed in these patients. We chose to use a single-stage combined procedure in these individuals to obtain all the advantages of an anterior decompression and strut graft reconstruction, yet avoid associated graft complications. Using the strategies described earlier, we achieved a 100% fusion rate

without associated graft problems. Only one plate (1.4%) failed by backing out at its rostral end, but fusion proceeded in this patient without further intervention.

Our results compare favorably with those reported in three recent series on combined anterior–posterior fusion. McAfee, et al.,³⁷ reported on 100 patients undergoing this procedure with a minimum 2-year follow up. A variety of conditions was treated including cervical spine tumors, trauma (with kyphotic deformity), rheumatoid arthritis, infection, cervical spondylotic myelopathy, and congenital deformity. Pseudarthrosis and progressive kyphosis requiring revision occurred in only two patients (2%), in each of whom progression of residual metastatic lesions was noted. Despite the fact that more than 50% of patients underwent radiotherapy for tumors pre- and postoperatively, a long-term complication rate of only 3% was reported. There were no cases of anterior or posterior hardware failure.

Swank, et al.,⁵¹ retrospectively reviewed 17 patients undergoing multilevel (three- to seven-level) anterior subtotal vertebrectomy, decompression, and allograft strut fusion with lateral mass plating and interspinous wiring. Although it was unclear whether anterior instrumentation was in standard use, no patient was treated with halo immobilization. At 24-month follow-up review, fusion was demonstrated in all patients and there were no significant changes in cervical alignment. The authors concluded that lateral mass plating provided rigid internal fixation and allowed maintenance of spinal alignment while eliminating the need for halo immobilization.

Finally, Foley, et al., (unpublished data, 1997), reported on 39 patients who underwent multilevel cervical corpectomies. Patients were divided into three treatment groups: 1) those who underwent anterior cervical plating alone, 2) those who underwent anterior cervical plating with postoperative halo immobilization, and 3) those who underwent anterior plating combined with posterior fusion and placement of instrumentation. Two cases of strut graft displacement were documented in each of the first two groups. No graft displacement occurred when a posterior fusion was performed. The authors of this study concluded that anterior plating alone does not decrease graft dislodgment in multilevel corpectomies. Furthermore, the results showed that the effect of posterior fusion was superior to that of halo immobilization in reducing graft complications.

Surgical Complications

Many surgeons have traditionally chosen to treat patients with more complex spinal deformities by using a single anterior or posterior approach, reserving the alternative approach for cases of progressive deformity, instability, or neurological decline.^{7,16,23–25,29,42} These investigators often cite the increased risk associated with a second operation. Based on the discussion of the aforementioned reports, however, it appears that the overall complication rates associated with combined procedures are, at worst, no greater than those associated with single anterior or posterior approaches.

Our rate of immediately perioperative complications was relatively high (32%) compared with rates of 17 to 35% reported with anterior, posterior, and combined re-

constructions;^{18,24,28,37,57} this may be related to our definition of a complication. For example, mild and transient dysphagia was considered a complication. In contrast, our long-term complication rate (5%) was low compared with those reported for series described earlier in this study.^{16,19,23,30,42,45,56,57} The pseudarthrosis and instrumentation failure documented by others using either an anterior or posterior approach did not occur in our series or in others in which combined anterior–posterior fusion procedures were performed for nonneoplastic diseases.^{37,38,51} Moreover, using simple hard collars, we were able to eliminate concerns about halo complications^{3,20} while reducing the barriers to immediate postoperative mobilization and rehabilitation.

CONCLUSIONS

The results of this study indicate that the single-stage anterior–posterior decompression, reconstruction, and instrumentation procedure represents a viable option for treating patients with select complex spinal disorders. This procedure allows for the restoration of sagittal balance and provides immediate rigid stabilization of the cervical spine, eliminating the need for postoperative halo immobilization. Furthermore, it has been our experience that the combined approach minimizes anterior plate failure and strut graft extrusion, thus offering higher rates of fusion for complex cervical spine diseases compared with isolated anterior or posterior approaches.

Patients undergoing this procedure should be selected on a case-by-case basis, because obviously not every patient with a cervical spine deformity requires a combined approach. In general, we consider a combined approach in patients with both anterior and posterior column instability or insufficiency due either to trauma or previous laminectomy. We also consider as candidates patients undergoing multilevel corpectomies (involving > two vertebral bodies) due to degenerative disc disease or OPLL, as well as patients with predisposing risk factors for pseudarthrosis (such as tobacco use, osteoporosis, diabetes, and dialysis).

The long-term durability of a combined anterior–posterior cervical spine fusion has yet to be proven. One particular concern about the production of long-segment rigid constructs is the potential for premature subjacent degeneration and instability—a problem that has recently come to light with long-term follow up of cases in which instrumentation was placed to achieve lumbar stabilization and fusion. Although the combined anterior–posterior approach appears to result in an increased rate of fusion, much remains to be learned regarding the optimum biomechanical environment for arthrodesis of the cervical spine.

Disclosure

Dr. Rodts has a financial interest in Medtronic Sofamor Danek, Inc., and Dr. Haid has a financial interest in Medtronic Sofamor Danek, Inc., and Codman Johnson and Johnson, Inc.

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