Comparison between anterior cervical discectomy fusion and cervical corpectomy fusion using titanium cages for reconstruction: analysis of outcome and long-term follow-up

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Abstract Retrospective comparative study of 80 consecutive patients treated with either anterior cervical discectomy fusion (ACDF) or anterior cervical corpectomy fusion (ACCF) for multi-level cervical spondylosis. To compare clinical outcome, fusion rates, and complications of anterior cervical reconstruction of multi-level ACDF and single-/multi-level ACCF performed using titanium mesh cages (TMCs) filled with autograft and anterior cervical plates (ACPs). Reconstruction of the cervical spine after discectomy or corpectomy with titanium cages filled with autograft has become an acceptable alternative to both allograft and autograft; however, there is no data comparing the outcome of multi-level ACDF and single-/multi-level ACCF using this reconstruction. We evaluated 80 consecutive patients who underwent surgery for the treatment of multi-level cervical spondylosis at our institution from 1998 to 2001. In this series, 42 patients underwent multi-level ACDF (Group 1) and 38 patients underwent ACCF (Group 2). Interbody TMCs and local autograft bone with ACPs were used in both procedures. Medical records were reviewed to assess outcome. Clinical outcome was measured by Odom's criteria. Operative time and blood loss were noted. Radiographs were obtained at 6 and 12 weeks, 6 months, 1 year, and 2 years (if necessary). Early hardware failures and pseudarthroses were noted. Cervical sagittal curvature was measured by Ishihara's index at 1 year. Group 1 had a mean age 46.2 years (range 35–60 years). Group 2 had

a mean age 50.1 years (range 35–70 years). The operative time was significantly lower ($P < 0.001$) and blood loss significantly higher ($P < 0.001$) in Group 2 than in Group 1. At a minimum of 1 year follow up, patients in both groups had equivalent improvement in their clinical symptoms. The fusion rates for Group 1 were 97.6 and 92.1% for Group 2. The rates of early hardware failure were higher in Group 2 (2.6%) than in Group 1 (0%). The fusion rates for Group 1 were not significantly higher than Group 2 ($P > 0.28$). There was one patient in Group 1 and 2 patients in Group 2 with pseudarthroses. Complication rates in Group 2 were not significantly higher ($P > 0.341$). Cervical lordosis was well-maintained (80%) in both groups. Both multi-level ACDF and ACCF with anterior cervical reconstruction using TMC filled with autograft and ACP for treatment of multi-level cervical spondylosis have high fusion rates and good clinical outcome. However, there is a higher rate of early hardware failure and pseudarthroses after ACCF than ACDF. Hence, in the absence of specific pathology requiring removal of vertebral body, multi-level ACDF using interbody cages and autologous bone graft could result in lower morbidity.

Keywords Cervical fusion · Cervical spondylosis · Anterior cervical discectomy and fusion · Anterior cervical corpectomy

Introduction

Multi-level cervical spondylosis is a challenging and a common clinical problem [48]. The ideal way of decompressing the neural elements and reconstructing the anterior cervical spine in treatment of multi-level

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cervical spondylosis is not clear. Although fusion rates are high with the use of autograft, it is associated with significant graft site morbidity [43]. Similarly, the use of allograft, which is devoid of any donor site problems, is associated with high rates of pseudarthroses [3]. To overcome these problems associated with both allograft and autograft, titanium mesh cages (TMCs) have become popular for anterior cervical reconstruction. The potential advantages of using interbody cages for reconstruction after anterior cervical corpectomy fusion (ACCF) include immediate anterior column stability, avoidance of morbidity associated with autologous bone graft (iliac crest) harvesting, and good biocompatibility [29]. Similarly, the use of anterior cervical plating (ACP) after multi-level anterior cervical discectomy fusion (ACDF) and ACCF has been regarded as standard practice [58].

It is also not clear whether multi-level cervical spondylosis is best treated with multi-level ACDF or single-/multi-level ACCF. When compared with multi-level ACDF (in which there are two surfaces per level), one hypothesis posits that cervical corpectomy should result in higher fusion rates because there are only two fusion surfaces [14, 30]. However, ACCF has been associated with early hardware failure [41, 43].

Because of the lack of data comparing the outcome of multi-level ACDF with ACCF using reconstruction with TMCs and ACPs, we decided to conduct this retrospective study. To the best of our knowledge, this is the only study reported in the English language comparing the outcome of multi-level ACDF and ACCF with reconstruction using cages. Similar studies were conducted earlier using allograft and/or autograft (Table 1).

Table 1 Comparative studies of anterior cervical decompression and reconstruction for multi-level cervical spondylosis

Author	Decompression	Reconstruction	Clinical outcome	Fusion rates	Hardware failures
Yonenobu et al. [61]	Multi-ACDF vs corpectomy	Autograft	Better with corpectomy	Better with corpectomy	None reported
Brown et al. [6]	ACDF	Autograft vs allograft	Equivalent	Equivalent	None reported
Fernyhough et al. [16]	Multi-level ACDF and ACCF	Autograft vs allograft	Equivalent	Better with autograft	None reported
Bishop et al. [2]	Single and multi-level ACDF	Autograft vs allograft	Autograft superior	Autograft superior	None reported
Samartzis et al. [40]	Multi-level ACDF	Autograft vs allograft with ACP	Equivalent	Equivalent	Equivalent in both groups
Rish et al. [38]	Multi-level ACDF	Autograft vs allograft	Equivalent	Equivalent	None reported
An et al. [1]	Multi-level ACDF	Autograft vs allograft and DBX	Autograft superior	Autograft superior	None reported
Cauthen et al. [7]	Multi-level Clowards vs instrumented Clowards	Autograft vs allograft	Autograft superior	Autograft superior	Higher in instrumented Clowards
Moreland et al. [32]	Single and multi-level ACDF	TMC vs allograft	Equivalent at 6 months	Equivalent at 6 months	Equivalent at 6 months
Hwang et al. [23]	Single and multi-level ACDF	TMC vs plated TMC	Equivalent	Equivalent at 12 months	None reported
Swank et al. [48]	ACDF vs corpectomy	Allograft and autograft	Corpectomy group better	Corpectomy group better	Equivalent
Nirala et al. [33]	ACDF vs corpectomy	Autograft	Corpectomy group better	Corpectomy group better	None reported
Cauthen et al. [8]	ACDF	Cage vs dowel vs dowel-plate	Equivalent	Cage group better	Higher in dowel-plate
Wang et al. [59]	Multi-level ACDF vs corpectomy	Allograft	Equivalent	Equivalent	Equivalent
Thome et al. [51]	ACDF	Titanium rectangular cages vs autograft	Equivalent	Equivalent	Equivalent
Hacker et al. [22]	ACDF	Cages vs uninstrumented allograft	Equivalent	Equivalent	None reported
Brazenor [5]	Corpectomy	Allograft vs titanium rods and buttress	Equivalent	Equivalent	None reported
Lind et al. [27]	ACDF	Titanium cages vs autograft	Superior in cage group	Equivalent	None

ACCF anterior cervical corpectomy fusion, ACDF anterior cervical discectomy fusion, TMC titanium mesh cage

Patients and methods

We conducted a retrospective analysis of 80 consecutive patients treated for multi-level cervical spondylosis between the years 1998–2001. Medical charts and radiographs were extensively reviewed by an independent observer (J.R. Sangala). Patients included in this group had multi-level symptomatic degenerative disc disease, disc herniation, or stenosis of the cervical spine with or without myelopathy and/or radiculopathy. All patients were carefully selected, having significant neural compression extending beyond two or more disc spaces in the cervical spine and were symptomatic even after appropriate conservative management. Patients who underwent surgery for infection, neoplasm, trauma, or ossified posterior longitudinal ligament (OPLL) were excluded from the study.

Patients were required to discontinue the use of all forms of nicotine for at least 6 weeks prior to surgical intervention. Serum nicotine levels were not measured preoperatively. Mean age at the time of surgery was 47 years (range 30–75 years). A diagnosis of cervical myelopathy was made in 8 out of 42 patients (19%) in the ACDF group and 10 out of 38 patients (26%) in the ACCF group. All patients underwent a preoperative clinical evaluation along with magnetic resonance imaging and radiographic studies of the cervical spine.

Operations were performed by the same neurosurgeon at a single institution. Those patients with neural compression from large end plate osteophytes at two adjacent levels requiring resection of a larger portion of osseous material were treated with a corpectomy. In those patients with compression from disc material without significant end plate osteophytes, the decision-making of the type of decompression (either ACDF or ACCF) involved a detailed discussion of potential benefits and risks of multi-level ACDF and ACCF between the patient and surgeon. No randomization was performed.

Based on the type of surgery the patients received, they were divided into two groups: Group 1 consisted of patients who received multi-level ACDF, and Group 2 consisted of patients who received single-/multi-level ACCF. Titanium interbody cages and local autograft bone were used in all procedures; specifically, Harms cages (DePuy, Inc., Raynham, MA, USA) were used as structural grafts during ACCF procedures and Rabea cages (Newport Medical, Chanhassen, MN, USA) were used as interbody grafts during ACDF. Cages were packed with autograft from the resected vertebra in the corpectomy group and from local cancellous bone harvested from the sternal manubrium and/or local osteophytes in the discectomy group. All cases were stabilized with a fixed ACP (DePuy, Inc. or Synthes, Davos, Switzerland). The Rabea cage is a “box”-type cage designed for implantation into the

cervical disc space after discectomy. It is designed to facilitate fusion by use of forced friction to stabilize the bones until osseous fusion both in and around the cage occurred. Harms cages used in this study were single oval, cylindrical meshed titanium cages. All the ACPs used in this study were non-constrained.

Follow-up radiographs and clinical examinations were obtained by the surgeon (F.L. Vale). Postoperative follow-up visits were done regularly at 6 and 12 weeks, 6 months, 1 year, and 2 years (if necessary). All patients had anterior–posterior and lateral cervical spine X-rays at each visit; flexion/extension views were obtained after 12 weeks. Patients were followed for at least 12 months. Fusion was judged by the absence of motion more than 2 mm between the spinous processes on flexion–extension lateral radiographs, the absence of radiolucent gap between the graft and end plate, and the presence of continuous bridging trabeculae at the graft and end plate junction [51]. Radiographs were studied to look for hardware failure. Subsidence and settling were recorded. Subsidence of more than 3 mm was considered significant [18]. Cervical sagittal balance (lordosis) was measured by Ishihara’s index. A negative value of Ishihara’s index indicates kyphosis and a positive value indicates lordosis [49]. Computerized tomography and SPECT scans were not routinely obtained to evaluate bone fusion. Postoperative clinical evaluation of patients was based on Odom’s criteria (Table 2). All patients had a minimum of 12 months of follow-up (range 12–46 months). None of the patients were lost to follow-up.

Data were recorded and statistical analysis performed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA). Data are presented as mean $\pm$ standard deviation. Mann–Whitney rank sum and Chi-Square tests were used to analyze differences in preoperative clinical and demographic characteristics (age, sex ratio) and in clinical outcome variables between groups (Odom criteria, fusion rates). Fisher exact test was used to analyze differences in

Table 2 Odom’s criteria

Rating	Odom’s criteria
Excellent	No complaints to cervical disc disease; able to continue daily occupation without impairment
Good	Intermittent discomfort related to cervical disease but not significantly interfering with work
Satisfactory	Subjective improvement but physical activities limited
Poor	No improvement or worse compared with the condition before the operation

Table 3 Showing number of disc levels operated in both the groups

Disc levels	Group1 (ACDF) <i>n</i> = 42	Group 2 (ACCF) <i>n</i> = 38
C3–4, C4–5	0	1
C3–4, C4–5, C5–6	0	1
C4–5, C5–6	6	9
C4–5, C5–6, C6–7	4	5
C5–6, C6–7	32	22

fusion and implant-related complications between groups. Statistical significance was set at $P < 0.05$.

Surgical techniques

Standard surgical techniques were used for both ACDF and ACCF as previously described [29, 46]. In all patients, ten pounds of traction was used to help stabilize the cervical spine and provide intra-operative disc space distraction. The Smith–Robinson technique was used for Group 1 [46]. After confirmation and exposure of the appropriate vertebral levels, a discectomy was performed and a high-speed burr used to remove the cartilaginous end plates from the adjoining vertebral bodies; excessive removal of the subchondral bone was avoided. The posterior longitudinal ligament was also completely removed in all patients. Among 42 patients who underwent ACDF, 38 patients underwent fusion at two levels, while another 4 patients were fused at three levels (Table 3). An ACP was used in all cases for internal fixation.

For ACCF cases, the vertebral body was removed using a channel technique [29]. In general, the anterior two-thirds of the vertebral body was removed with rongeurs and the posterior one-third was removed using a high-speed burr. The posterior longitudinal ligament was completely removed in all patients. An ACP was used routinely for internal fixation. Among 38 patients who underwent ACCF, corpectomy at one level was performed in 32 patients and two levels in 6 patients (Table 3).

The nuances mentioned by Perez-Cruet et al. [37] were followed in both groups. All patients wore an Aspen cervical collar for immobilization for at least 6 weeks postoperatively.

Results

Group 1 was composed of 42 patients and Group 2 had 38 patients. The average age of patients in Group 1 was 46.2 years (range 35–60 years) and 50.1 years (range 35–

70 years) in Group 2 (Table 4). Outcome as measured by Odom's criteria was identical in both groups. Excellent outcome was reported by 83.3% of the patients in Group 1 and 79% in Group 2 (Table 5). The average operative time in Group 1 was 220 ± 30 min (range 160–280 min), and was significantly higher ($P < 0.001$) than Group 2, which was 160 ± 20 min (range 110–230 min). The average blood loss in Group 1 was 150 ± 23 ml (range 100–350 ml), and was significantly lower ($P < 0.001$) than Group 2, which was 375 ± 30 ml (range 250–600 ml; Fig. 1). None of the patients in either group developed any new neurological deficits. No patient in either group developed recurrent laryngeal nerve palsy, esophageal injury, cerebrospinal fluid leak, or infections (Table 6). Group 1 had one occurrence of pseudarthrosis and no hardware failures. The patient with pseudarthrosis in Group 1 did not require re-operation and continued to be asymptomatic at 5-year follow-up. In Group 2, two patients developed pseudarthrosis and one patient had early hardware failure. All three of these patients in Group 2 required re-operation. The fusion rates in Group 1 were 97.6 and 92.1% for Group 2. Sagittal balance was well-maintained (80%) in both groups.

The case of early hardware failure in Group 2 was associated with screw pull-out and cage dislodgement, and the patient presented with dysphagia. This patient was managed by removal of the ACP, placing a buttress anterior plate, repositioning the cage, and posterior fusion. The two patients with pseudarthrosis in Group 2 were managed by posterior fusion.

Table 4 Population demographics

	Group 1 (ACDF)	Group 2 (ACCF)
Number	42	38
No of females/no of patients	21	17
Average age (years)	46.2	50
Myelopathy as pre-dominant presentation	7	11
Average follow up (years)	2.3	2.2
Average operation time (min)	220	160
Average blood loss (ml)	150	375

Table 5 Results of surgery according to Odom's criteria sorted by procedure

	Excellent	Good	Fair	Poor
Group1 (ACDF) <i>n</i> = 42	35 (83.3%)	6 (14.3%)	1 (2.34%)	0 (0%)
Group2 (ACCF) <i>n</i> = 38	30 (78.9%)	6 (16.8%)	2 (5.3%)	0 (0%)

There is no statistically significant difference between the two groups

Fig. 1 **a** Graph depicting the lower average blood loss in the ACDF group. **b** Graph depicting the lower operative time in the ACCF group

Discussion

Surgical treatment of multi-level cervical spondylosis is challenging. Type of decompression and the technique of reconstruction are the two important decisions to be made. The types of decompression usually used are multi-level ACDF or single-/multi-level ACCF. Since its initial description in the mid-1950 s by Smith and Robinson [46] and Cloward [11], anterior cervical discectomy for cervical spondylosis has been reported with good clinical outcome and fusion rates. In the decades that followed, various modifications of these landmark techniques have been

Table 6 Complications

Complications	Group1	Group2
Early graft displacement	0	1
Pseudarthrosis	1	2
Infections	0	0
Recurrent laryngeal nerve injury	0	0
Esophageal injuries	0	0
CSF leaks	0	0

described in the literature, including the addition of ACP by Orozco in 1970 [34].

Fusion rates are high (up to 96%) using either an autograft or allograft with ACP for single-level ACDF [39]. However, fusion rates were much lower for multi-level ACDF using either autograft or an allograft. Non-union rates of 26% for two-level ACDF and 48% for three-level ACDF have been reported in the literature [48]. One of the reasons postulated for the high non-union rates after multi-level ACDF is the higher number of fusion surfaces involved. Some surgeons have advocated the use of cervical corpectomies as an alternative to multiple interbody grafts, citing a decreased rate of pseudarthrosis secondary to fewer graft–host interfaces where fusion needs to occur [33, 48, 50]. In anterior reconstruction after corpectomy, fibular strut grafts were associated with a non-union rate as high as 41% for allograft and 27% for autograft [16]. Some studies have reported high fusion rates using an autograft for reconstruction after corpectomy [20]; however, the use of autograft has significant donor site morbidity [43]. Also, results of using autograft for vertebral defects greater than 6 cm have been disappointing [48]. Hence, the use of autograft for reconstruction is decreasing. Allograft has the advantage of providing immediate mechanical strength, availability in the desired shape, size, and quantity. But the important disadvantage of allograft is the high non-union rate when used for multi-level ACDF and also corpectomy [46]. In view of the disadvantages of both allograft and autograft, the TMC designed by Harms in 1986 became an alternative method of reconstruction in these procedures.

Titanium mesh cages have been used in anterior reconstruction of the spine for trauma and tumors with adequate results [29, 50]. High fusion rates have been reported after cervical corpectomies using TMC (up to 100%) [50]. All of the studies we reviewed have reported higher fusion rates after corpectomy than multi-level ACDF [33, 48, 61] when using similar reconstruction techniques (Table 1). Contrary to these results, our study found slightly higher fusion rates after multi-level ACDF than ACCF. We believe these findings are due to the higher fusion rates in the ACDF group, since the fusion rates for the ACCF group (92.1%) were comparable to other series

[29, 50]. The higher fusion rates in the ACDF group in our study could be due to strict adherence to surgical principles of anterior cervical fusion, such as preserving the end plates, avoiding over-distraction, the use of local autograft and supplemental autograft from sternal manubrium in selected cases, and the use of cages instead of allograft. Our results are similar to those of Wang et al. [59], who reported similar fusion rates in both multi-level ACDF and ACCF groups using allograft.

Bone graft is usually packed inside the cage to serve as a bone graft substrate. In our study, the cages were filled with local bone saved from corpectomy in Group 2 and from osteophytes and sternal manubrium in Group 1. Sternal manubrium has shown to be a safe and effective source of autograft without donor site morbidity [36].

We believe that our study is unique in that it presents for the first time the outcome of multi-level ACDF and ACCF using TMCs for reconstruction. Similar studies have been performed using either an allograft or autograft (Table 1). Other contemporary methods used for reconstruction include artificial disc, PEEK cages, carbon fiber cages, and titanium rods with buttress prosthesis [5]. The cervical artificial disc has been recently approved by the United States Food and Drug Administration (FDA) and is still not widely used [27]. PEEK cages have certain advantages over metal cages as they are radiolucent and have the same modulus of elasticity as bone [26] and appear to be an alternative to metal cages. Numerous modifications have been used for corpectomy, reporting greater safety and equivalent outcome [9, 21, 60]. An important advance in spinal fusion has been the use of BMP-2. However, the FDA has not approved the use of BMP-2 for cervical fusion, and complications have been reported with the use of BMP-2 in cervical fusion [54]. Polymethylmethacrylate (PMMA) has been reported to produce satisfactory results in ACDF [10]. However, PMMA fails to meet the requirements for an interbody fusion device and causes necrosis of adjacent vertebrae [56].

The strengths of our study include the involvement of two groups with very similar demographics, a relatively large number of patients, use of a contemporary technique for spinal reconstruction, all surgeries performed by a single surgeon at a single institution, and good follow-up data for at least 1 year post-surgery (no patients lost to follow-up). The limitations of our study include the potential for surgeon bias in patient selection in patients with no compelling reason to perform a corpectomy, lack of randomization of the treatment group, and importantly, the disadvantages of a retrospective study.

In our series, no patient experienced infection, recurrent laryngeal nerve palsy, or esophageal perforations. Infection rates in most series are low (<0.5%) [31, 52, 63]. Although no patient in our series developed cerebrospinal fluid leak,

several published reports describe this problem in corpectomies and were associated with severe spondylosis, multiple re-operations, or OPLL [14, 15, 28].

Clinical outcome was comparable in both groups and was similar to earlier reports [59]. However, the rate of postoperative hardware failure and fusion failure was higher in those undergoing corpectomy. Our study underlines both the advantages and the pitfalls with the use of TMCs and ACPs in reconstruction of the anterior cervical spine. The advantages are the high fusion rates as shown in the present study. These high fusion rates could be due to the decreased incidence of significant subsidence. Although Gercek et al. [18] reported a high incidence of subsidence, other authors with larger numbers of patients have reported lower rates [4]. We believe that careful preservation of the end plates and avoiding of over-distraction are very important to avoid significant subsidence. Non-significant subsidence is not associated with any complications and may, on the other hand, help fusion [42]. TMCs are sufficiently rigid and are designed to resist compression and torque [35]. The addition of an ACP resists bending forces and theoretically protects against dislodgement of the cage, helps in maintaining cervical lordosis [24, 53], and is reported to have higher fusion rates [58, 62].

Though it has become a routine practice to use ACP after multi-level ACDF and also single-/multi-level corpectomy, there are both clinical and biomechanical disadvantages of using plates. One disadvantage of using a fixed ACP is that it prevents subsidence and may prevent the proper contact of the graft with vertebral end plates [47]. The use of ACP in spine reconstruction with multi-level corpectomies is also technically demanding and fraught with complications (e.g., plate migration or dislodgment) [12, 41]. DiAngelo et al. [13] demonstrated that, following multiple level corpectomies and strut grafting, though ACP effectively increased stiffness and decreased local cervical motion after corpectomy, it was also shown to reverse graft loads and excessively load the graft in extension, which may promote pistoning and failure of a multi-level construct. Similarly, Foley et al. [17] in a biomechanical cadaveric study concluded that, although multi-level cervical instrumentation effectively increased stiffness after corpectomy, anterior or posterior plating alone excessively loads the graft with a small degree of motion and may promote pistoning and failure of multi-level constructs.

As described by Vaccaro et al. [55] and Sasso et al. [41], the incidence of early plate/construct failure increases significantly with a three-level corpectomy compared with one or two levels. In their practice, the authors limit corpectomy procedures to two levels. In our series, in Group 2, we used an end-construct plate fixation that spanned the graft. Our study also highlights the pitfalls of a long fusion ending at C7, which has also been reported

earlier [57]. In addition to graft length, the actual level fused appear to have an effect on graft stability. All 3 complications in the corpectomy group involved C6 as the caudal corpectomy level, with the fusion extending to the C7 vertebral body. A large moment arm can be generated at the ends of the construct, potentially leading to plate dislodgment. The tendency for bone fusion failure for cervical procedures extending to the level of C7 might be related to transition from cervical lordosis to thoracic kyphosis. This sharp angular change could lead to increased stress at the graft end plate interface, resulting in higher probability of construct failure, as described by others [19]. We are also aware that this inherent morbidity of multi-level fusions can simply reflect the fact that long constructs usually do extend to C7. Consideration of supplemental dorsal fixation and/or external immobilization (halo vest) should be given for a long construct that spans the cervical–thoracic junction (C7–T1). We believe that the increased rigidity afforded by posterior segmental fixation may decrease the likelihood of cage dislodgment observed in the setting of long fusion with anterior instrumentation alone. The increased fixation provided by dorsal fusion allows the large-cantilever forces generated across the cervical spine to be distributed across multiple screw–host interfaces.

The results of our study indicate there is less morbidity with multi-level ACDF than ACCF. Some biomechanical studies have also addressed the stability of multi-level ACDF and ACCF [25, 44, 45]. In a biomechanical cadaveric study, Singh et al. [44] evaluated the biomechanical stability of ACP fixation following three strategies for decompression of spondylosis (three levels) of the cervical spine: three-level discectomy, single-level corpectomy, and two-level corpectomy. They concluded that a large moment arm is generated at the ends of the construct after multi-level corpectomy, potentially leading to plate migration or dislodgement. They also reported that segmental plate fixation affords a more biomechanically rigid reconstruction. In another biomechanical cadaveric study, Kirkpatrick et al. [25] determined the biomechanical behavior of the cervical spine after multi-level corpectomy and reconstruction with a strut graft and supplementation with anterior and posterior plates. They concluded that plating increases stability of the spine after multi-level corpectomy. Interestingly, they found that posterior plating provided more rigidity than ACP. These two cadaveric studies appear to be the biomechanical basis of clinical findings reported in our study.

Conclusions

On the basis of our findings, we believe that both multi-level ACDF and ACCF with anterior cervical

reconstruction with a TMC filled with autograft and ACP for treating multi-level cervical spondylosis have high fusion rates and good clinical outcome. However, there is a higher rate of early hardware failure and pseudarthrosis after ACCF than ACDF. In view of the equivalent fusion rates using TMC and autograft, in the absence of specific pathology that would require removal of vertebral body, multi-level ACDF using interbody cages and autologous bone graft could result in lower morbidity. We also propose that in patients who undergo a multi-level corpectomy with a construct that involves C7, additional posterior stabilization or postoperative immobilization should be considered to protect against construct failure.

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