

## Chapter 43

# Surgical Management of Cervical Disc Disease: From No Fusion to Fusion and Back Again

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The surgical management of cervical degenerative disc disease is still controversial despite the many studies published on this topic. This article reviews the various surgical treatment options for cervical degenerative disc disease, focusing on prospectively collected data comparing various surgical treatment modalities.

### HISTORICAL BACKGROUND

Early surgical treatment of the cervical spine for neural decompression used the posterior approach to perform cervical laminectomies for trauma and degenerative disease (44, 60, 88). Scoville et al. (72) and Frykholm (31) refined the posterior cervical approach for degenerative disc disease and introduced the laminoforaminotomy technique. About 20 years later, a number of surgeons introduced anterior cervical discectomy with fusion (ACDF) for degenerative disc disease. Robinson et al. (67), Dereymaeker and Mulier (25), and Baily and Badgley (8) recommended fusion of the involved segment without decompression of the spinal canal from dorsal osteophytes. After immobilization of the degenerated segment, resorption of dorsal osteophytes was documented (67). In 1958, Cloward (20) first introduced the concept of ACD without fusion and direct surgical decompression of dorsal osteophytes. About the same time, the concept of ACD without fusion was successfully applied (43).

Overall, clinical outcomes associated with the surgical treatment of degenerative disc disease by ACD or ACDF have been excellent. According to a literature review from 1991 (38), good clinical outcomes have been reported for 61% to 94% of ACDF cases and for 65% to 96% of ACD cases. These data showed that an interspace fusion is not mandatory for good clinical outcomes. The development of a fibrous union or pseudarthrosis has not been consistently associated with poor clinical outcomes. However, once pseudarthrosis is present, 67% of patients have associated symptoms (63). Since then, the question of whether an interbody fusion is required has been unresolved (77). Proponents of ACD favor its simplicity, low cost, and the absence of complications related to autograft harvest and interbody graft failure (e.g., graft extrusion, collapse, subsidence, and pseudarthrosis). Advocates of ACDF stress that foraminal decompression by interbody distraction, prevention of disc space collapse, and stabilization of cervical alignment are key advantages compared with ACD alone. The resorption of dorsal osteophytes has been attributed to fusion and immobilization of the segment. The postoperative incidence of neck pain has been reported to be smaller with fusion than without. Furthermore, the incidence of kyphotic deformity is thought to be higher if fusion is omitted. Comparative, prospective clinical studies between ACD and ACDF, however, failed to find a clinical benefit to ACDF (1, 9, 26, 56, 68, 69, 86, 92).

Despite these findings, the overall trend in the United States and Canada has been toward increased application of anterior interbody fusion for the treatment of cervical degenerative disc disease (7, 27, 94). Autograft from the iliac crest has mostly been used for interbody fusion. However, its harvesting is associated with complications such as prolonged pain, cosmetic deformity, wound infection, hematomas, and peripheral nerve irritation or injury (3, 20, 72). Consequently, alternative interbody implants were sought.

## AUTOGRAFT VERSUS ALLOGRAFT

Cloward (20) first successfully used allograft for cervical interbody fusion. Allograft became one of the most frequently used interbody implants. Unplated anterior cervical interbody fusion for degenerative disc disease has a higher tendency to fuse with autograft than allograft, sometimes with better clinical outcomes (5, 12, 28). In contrast, other studies failed to demonstrate significant differences in radiological or clinical outcomes between allograft and autograft (66, 70, 87, 93). A meta-analysis of the literature comparing fusion outcomes of allograft and autograft for one- and two-level cervical interbody fusion without plating found a higher fusion rate for autograft and a lower incidence of graft collapse than for allograft. However, clinical outcomes were statistically similar (30). A review of the literature failed to find allograft to be an adequate equivalent to autograft for anterior cervical interbody fusion (91). However, the morbidity associated with autograft harvest was eliminated by the application of allograft. The possibility of transmitting infectious diseases like human immunodeficiency virus (HIV) from tissues, including allograft, donated by a screened donor is exceptionally rare (75, 76).

## OTHER INTERBODY IMPLANTS AND DEVICES

In 1968, Grote (37) introduced the acrylic poly-methyl-methacrylate (PMMA) as an interbody construct for degenerative disc disease of the cervical spine. Other materials applied included xenografts, ceramics (tricalcium-phosphates and hydroxy apatites), biopolymers, tantalum blocks, cylindrical titanium mesh, titanium, carbon fiber or resorbable cages, and titanium disc spacer (3, 6, 9, 16, 23, 39, 46, 50–52, 55, 58, 73, 80, 81, 83, 85, 86, 91). In a prospective, randomized trial, the radiological outcomes of ACDF with PMMA were inferior to those of ACD only. No significant clinical difference was noted. However, based on these data, the application of PMMA was not recommended when fusion was desirable (86).

A prospective study of ACDF comparing autograft and biocompatible osteoconductive polymers found significantly less graft protrusion and intersegmental kyphosis in the biocompatible osteoconductive polymer group. However, this study failed to demonstrate incorporation or biodegradation of biocompatible osteoconductive polymers (55). In a prospective, nonrandomized study, Senter et al. (73) compared outcomes of autograft ACDF with ACDF with hydroxylapatite. Fusion with the latter was equal or superior to that with autograft alone. In prospective comparisons of autograft and xenograft, clinical and radiological data favored the use of autograft (53, 64).

Recent prospective clinical trials of fusion with interbody titanium cages have found promising clinical results and radiological outcomes, with low rates of implant failure (e.g., backout and subsidence) or pseudarthrosis when compared with allograft or autograft (39, 58, 83). Even the fusion rates for cages are superior to those associated with autograft or allograft fusion (9, 39). Despite these recent data, some conclude that autograft remains superior to alternative interbody fusion materials (91).

## ANTERIOR CERVICAL INSTRUMENTATION FOR DEGENERATIVE DISC DISEASE

In the early 1960s, Bohler (13) applied an anterior cervical plate and screw construct to treat traumatic instability of the spine. After his report, anterior cervical plate constructs were applied using bicortical, nonlocked, variable-angle screws for fixation (18, 61). However, hardware failure was common (62), and a unilateral locked, fixed-angle plate-screw anterior system was introduced by Morscher et al. (59) in 1986.

A variety of unicortical locked, dynamic, fixed, or hybrid plate-screw systems are now available for anterior cervical interbody fusion and plating (40) to increase stability of the cervical fusion segment. As a result, fusion rates have increased, and the rates of graft failure and pseudarthrosis have thereby decreased (19, 89). Furthermore, anterior cervical plate fixation for degenerative disc disease maintains sagittal balance more effectively (33, 48, 84) (Fig. 43.1), thereby potentially limiting adjacent level biomechanical stress (49). Postoperative loss of lordosis and cervical kyphosis have been associated with ACD and ACDF without plating (Figs. 43.2 and 43.3). Yet, again, prospective randomized studies comparing single-level ACD, ACDF, and ACDF with plating have failed to show a clinical benefit associated with either procedure (69, 95), although a clinical benefit was found for two-level procedures (96). Moreover, concern has been expressed about the cost and complication of cervical plating for the treatment of degenerative disc disease. Hardware failure has been a source of early and delayed morbidity (53). In a prospective clinical trial, patients undergoing ACDF with plating tended to have a more frequent incidence of dysphagia than patients without plating. Yet, in the same study, more multilevel procedures were performed in the plating group, which could also account for these findings (11).

In more recent surgical series, refinements in the design of anterior cervical plating and more surgical experience have lowered the incidence of plate-related complications (10, 14, 21, 36, 47, 55, 74). When all aspects, including possible reoperation and time to return to work, are considered, overall costs decrease when anterior cervical plating is added to fusion (57, 74). Plating also may increase fusion rates with allograft and thereby obviate the need for autograft (54). The complications associated with autograft harvest would be decreased without compromising fusion rates. Again, experts are divided on the need for plating, in particular, for single-level disease (4, 15, 32, 78).

#### ANTERIOR AND POSTERIOR SURGERY FOR DEGENERATIVE DISC DISEASE

Whether the benefits of anterior or posterior approaches for the treatment of degenerative cervical disc disease differ is also unresolved. Posterior laminoforaminotomy has proven safe and effective, particularly for posterolateral foraminal decompression of soft herniated cervical disc material (Fig. 43.4), osteophytes, or both (41, 42, 71, 79). The recurrence rate for soft cervical disc herniations treated by the posterior approach is 3 to 6% (24, 41). The procedure is limited by the inability to decompress the contralateral cervical nerve root foramen or to access anteromedial compression of the cervical spinal canal. Immediate moderate-to-severe pain and prolonged postoperative axial neck pain also have been noted. Limiting the degree of medial facetectomy to less than 50% prevents postoperative instability (65). Because fusion is not applied, concerns about associated morbidity and the later development of adjacent level disease (ALD) theoretically are relatively minor.

Furthermore, the more severe complications potentially associated with any anterior approach (e.g., dysphagia, dysphonia, neurovascular injury, esophageal perforation, pneumothorax, or Horner's syndrome) are much less likely to occur with a posterior approach. Larger blood loss is often expected with the posterior approach but can be minimized with the application of less invasive techniques (2, 17, 29). Prospective studies comparing posterior and anterior approaches for the management of cervical degenerative disc disease have found no significant differences in outcome, although a trend toward better results has been noted with ACDF (42, 92).

#### ARTIFICIAL CERVICAL DISCS

After cervical spinal fusion, increased motion has been documented at adjacent levels (90), and radiological data have shown degenerative disc disease to occur at adjacent cervical segments on long-term follow-up (35). Whether the increased incidence of degenerative ALD found in the cervical spine after fusion is caused by increased mechanical stresses on adjacent cervical segments or whether the observed degenerative cervical changes merely represent the natural history of degenerative disc disease of the cervical spine is unknown. The rationale underlying the use of artificial discs is to maintain physiologic segmental cervical motion after ACD and decompression of the neural structures. By maintaining cervical segmental motion, adjacent level motion is decreased (90). Theoretically, this decrease should eliminate or reduce the incidence of ALD. Several artificial discs have been designed and applied clinically (22, 34, 45). Short-term follow-up data have shown equivalent clinical outcomes when cervical degenerative disc disease is treated with conventional fusion or an artificial cervical disc (34, 45). Earlier designers of artificial cervical joints showed a more frequent incidence of hardware failure (22) when compared with more recent clinical evaluations of cervical artificial joints (34, 45). Whether these devices will be associated with superior clinical outcomes compared with standard surgical treatment options for cervical degenerative disc disease will only be determined when sufficient long-term follow-up data have been gathered from ongoing clinical trials in the United States and Europe.

## CONCLUSION

Cervical degenerative disc disease is one of the most common and frequently treated entities managed by neurosurgeons and orthopedic spine surgeons. Yet, there is no consensus on the best surgical approach for this entity. The trend has been to treat degenerative cervical radiculopathy from the anterior approach with subsequent fusion. The application of anterior cervical plating to manage this disorder has also increased.

However, the gold standard for treating symptomatic degenerative disc disease after conservative management has failed depends on the actual manifestation, extent, and presentation of cervical degenerative disc disease. A soft cervical disc herniation might benefit from a different surgical strategy than hard cervical disc disease (cervical spondylosis). Compression of the anterior median or paramedian cervical spinal canal might benefit from a different surgical strategy than compressive sources located laterally in the nerve root foramen or lateral cervical recess. Posterior compressive sources might require a different approach than the management of anteriorly located compressive pathology. Multisegmental or bilateral degenerative disease might need a different surgical treatment than degenerative disc disease involving a single level or just one side. Cervical degenerative disc disease with axial neck pain might require a different surgical strategy than cervical degenerative disc disease without axial neck pain. We try to include all of these parameters in our clinical and surgical decision making (82). However, none of these issues is associated with clear treatment guidelines.

Another concept of motion-sparing surgery for cervical degenerative disc disease is being added to the surgical options for this disease entity. The rationale for motion-sparing surgery is to try to prevent or reduce ALD observed after cervical fusion procedures, a complication not yet even proven to occur. About 100 years after surgery of the cervical spine for the treatment of degenerative disc disease was introduced, a consensus on the best surgical treatment of degenerative disc disease is still lacking. The need for prospective, randomized, multicenter studies is becoming more imperative than ever.

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- FIG. 43.1 Lateral cervical spine radiograph obtained 1 year after anterior cervical discectomy with fusion with allograft and plating at C5-6. The patient is now asymptomatic. Sagittal balance was maintained.
- FIG. 43.2 Sagittal T2-weighted MRI of the cervical spine obtained 10 years after anterior cervical discectomy of C5-6 showing loss of lordosis with fusion at C5-6 in slight kyphosis. The patient is now asymptomatic.
- FIG. 43.3 Sagittal T2-weighted MRI of the cervical spine obtained 9 years after a two-level anterior cervical discectomy with fusion with autograft confirms fusion at C4-5 and C5-6 with loss of physiologic lordosis. The patient is now asymptomatic.
- FIG. 43.4 *A*, sagittal and, *B*, axial T2-weighted MRIs show the left disc herniation between C6-7. The patient was symptomatic with left C7 radiculopathy and triceps weakness but no neck pain. After a posterior laminoforaminotomy, the disc was removed. The patient's radiculopathy improved immediately after surgery. However, the patient complained of moderate neck pain for 2 weeks after surgery.