Anterior cervical discectomy: is fusion necessary?

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Object. A prospective, randomized trial was performed to compare the efficacy of anterior cervical discectomy (ACD) with ACD and fusion (ACDF) for the treatment of cervical spondylosis in patients with neurological compromise.

Methods. Forty-four patients underwent ACD and 40 underwent ACDF. Operative time and length of hospital stay were shorter and there was less need for analgesia in the ACD group. It was found that whereas the incidence of fusion was greater in the ACDF group compared to the ACD group (97 compared with 70%, respectively; p < 0.01), patient satisfaction and a return to preoperative activity level was similar between groups.

Conclusions. Analysis of the results suggests that the addition of a fusion procedure may be unnecessary.

Key Words • cervical spondylosis • discectomy • radiculopathy • anterior cervical surgery

Cervical spondylosis is a process in which degeneration and instability in the spine are compensated by hypertrophy of the supporting ligamentous structures and bony outgrowths. This process has been described as occurring in three phases: dysfunction, instability, and stabilization. The endpoint of this process is autofusion of the involved joint space, and the proximity of neurological structures to the spine can lead to undesirable neurological side effects. By narrowing the bony spaces within which neural structures lie, compression and dysfunction can occur. Radiculopathy or myelopathy can develop.

The relation of spinal cord injury to clinical deficit has been recognized since first described by Galen. However, patients with these problems were left untreated for the most part until the advent of roentgen-ray technology. The surgical treatment of lesions causing neural compromise came as an extension of the treatment for herniated lumbar and then cervical disc disease. In the 20th century, cervical spondylosis became much more frequently recognized.

Initially, the posterior approach to the cervical spine was utilized. Although this yielded favorable results for soft, accessible disc fragments, it provided limited access to and exposure of midline disc fragments and calcified spurs characteristic of cervical spondylosis. Based on the limitations of the posterior approach, the anterior approach to intervertebral disc disease was developed at several institutions, apparently independent of each other. Since this time, although controversy has developed concerning the superiority of the anterior or the posterior approach, it has not been demonstrated that one is better than the other. As such, both still have their proponents and detractors.

Initial descriptions of the anterior approach for cervical discectomy all included a fusion procedure. Concern over the possibility of developing late kyphosis from disc space collapse or radiculopathy from foraminal narrowing supported this philosophy. However, it became clear that whereas some patients experienced relief of radicular symptoms, others developed complications related to the fusion procedure. Several surgeons began to perform simple discectomy without the addition of fusion.

The necessity of a fusion procedure has come into question. In the absence of a randomized, prospective study in patients with cervical spondylosis that compares anterior cervical discectomy (ACD) with and without fusion, firm recommendations regarding the superiority of either approach are difficult to support.

Clinical Materials and Methods

Patient Population

The series reported in this study represents a 3-year experience from 1986 until 1989. One hundred consecutive patients presenting with cervical spondylosis of one or two disc levels and a diagnosis of radiculopathy or radiculomyelopathy were evaluated for the study. Sixteen patients either withdrew from the study due to personal treatment preferences or did not meet inclusion criteria. The remaining 84 patients were prospectively randomized using a closed-envelope technique to ACD alone or with...
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a fusion (ACDF) procedure. This protocol was reviewed and approved by the institutional review board.

All of the patients in this series were managed by the principal investigator (F.P.W.). Additionally, the procedures were performed at a single institution in conjunction with a single core neurosurgical operating room staff to ensure a modicum of consistency. The setting was favorable for this study because the patient pool was largely drawn from the local area, which aids in patient follow up.

Surgical Technique

The surgical technique was consistent in all cases, with the incision made through an appropriate horizontal skin fold on the right side of the neck. Dissection was performed through the usual route medial to the carotid sheath but lateral to the tracheoesophageal bundle. Lateral x-ray films were obtained to confirm vertebral level. The Cloward retractor system was used deep to the longis colli muscle group. Discectomy was performed using a Smith–Robinson technique but with opening of the posterior longitudinal ligament in all cases and removal of posteriorly directed osteophytes with curette and Kerrison rongeur. Patients with radiculopathy underwent foraminal augmentation. The cartilaginous endplates were carefully removed.

Fusion Procedure

An additional fusion procedure was performed in those patients randomized to the ACDF arm of the study. Using a modified Cloward technique, iliac crest autograft bone was utilized for fusion. The recipient site and graft were tailored to ensure a snug fit, which was facilitated by using cervical traction. No screw or plate fixation was used. Tissues and skin were closed with absorbable sutures. No drains were used. Postoperatively, ACDF patients wore a soft collar for a period of 6 weeks.

Clinical follow-up review was performed while patients were still hospitalized, during two office visits (at 5 and 10 weeks), and at delayed phone contact (mean 4.5 years, range 1.5–8 years).

Results

Following randomization, 44 patients underwent ACD and 40 patients underwent ACDF. These groups were found to be comparable on the basis of their demographic data (Fig. 1 upper left), symptoms per patient history (Fig. 1 upper right), findings on physical examination (Fig. 1 lower right), and the form of preoperative therapy that each received (Fig. 1 lower right). Importantly, the number of patients with problems caused by motor vehicle accident or involved in compensation claims was similar between groups. More patients in the ACDF group than in the ACD group (10 of 40 compared with one of 44, respectively; p < 0.005) complained of arm weakness. However, the results of physical examination (“weakness”: 18 of 40 ACD compared with 18 of 44 ACDF patients; difference not significant) did not support this difference between groups.

The distribution of surgically treated disc levels and ratio of one- to two-level procedures was similar between groups (Fig. 2). Two-level procedures were performed in 59% of the ACD group compared with 50% of the ACDF group.

The presence of myelopathy was determined by evidence of hand intrinsic musculature weakness and/or pathological long-tract findings. Gait, bowel, and bladder function were not recorded. By these criteria, 12 patients
in the ACD group and 14 patients in the ACDF group demonstrated signs of myelopathy.

Operative time was approximately 29 minutes longer in the ACDF than in the ACD group (131 compared with 102 minutes, respectively; \( p < 0.001 \)). This difference and significance were maintained when one-and two-level procedures were compared separately. The length of time in the postoperative unit was not different between groups (103 in ACDF patients compared with 98 minutes in ACD patients; difference not significant).

Postoperative results were quite different between the two groups. There was no perioperative mortality and no major neurological deficit. Minor deficits were present in both groups, all of which resolved or were improving prior to discharge (Table 1). There were significantly fewer medical complications in the ACD group than in the ACDF group (four of 44 compared with 10 of 40 patients, respectively; \( p < 0.05 \)) during hospital stay. These were mild (such as atelectasis and urinary tract infection), and none resulted in long-term sequelae. Patients in the ACD group were significantly more satisfied with their pain relief than those in the ACDF group (“resolved”: 34 of 44 compared with 20 of 40, respectively; \( p < 0.01 \)) on the morning following surgery. Patients who underwent ACD requested fewer narcotic shots than those who underwent ACDF (3.5 compared with 3.6, respectively; difference not significant), narcotic pills (3.6 compared with 4.4, respectively; \( p < 0.05 \)), and nonnarcotic analgesics (0.4 compared with 1, respectively; \( p < 0.01 \)). Duration of hospital stay was shorter for the ACD group than the ACDF group (3.6 compared with 5 days, respectively; \( p < 0.005 \)).

The two groups were evaluated for radiographic evidence of fusion. Thirty-one patients in each group underwent complete flexion–extension cervical x-ray series postoperatively. Patients who underwent two-level procedures that showed fusion at only a single level were classified as failures. Patients in the ACDF group had a statistically greater fusion rate compared to those in the ACD group (30 of 31 compared with 22 of 31; \( p < 0.01 \)). Stratification of patients between one- and two-level procedures, smoking history, or age did not demonstrate any difference in fusion success by using multivariate analyses. However, women were found to have a lower rate of successful fusion when compared with men (28 of 37 compared with 24 of 25, respectively; \( p < 0.05 \)) regardless of procedure type. Examples of postoperative radiographic studies are presented in Fig. 3.

Postoperative follow-up examination at the first office visit revealed that the discrepancy in pain relief abated by 5 weeks: 40 of 44 ACDF patients compared with 37 of 40 ACDF patients had “improved” pain relief. At the 10-week visit there was near universal improvement in pain: 31 of 32 ACDF patients compared with 35 of 35 ACDF patients. The number of patients returning to work was greater in the ACD than in the ACDF group at both the first (10 of 44 vs. four of 37, respectively; difference not significant) and second (12 of 32 compared with 10 of 33, respectively, difference not significant) office visits. Data from phone follow up (average 4.5 years) demonstrated some recrudescence of pain, although this was similar between groups. Some patients complained of “severe pain” (ACD four of 33 compared with ACDF five of 23; difference not significant). More patients in the ACD than in the ACDF group maintained their preoperative level of activity (24 of 33 compared with 15 of 23, respectively; difference not significant). When asked whether the procedure “helped and would be worth repeating given a second chance,” patients from both groups were largely satisfied (33 of 33 ACD compared with ACDF 22 of 23; difference not significant). However, no statistical difference between groups was found at this follow up.

Three patients required a subsequent operative procedure, two from the ACD group and one from the ACDF group. The first patient had persistent radicular symptoms following a C5–6 and C6–7 ACD. At 4 months postoperatively, a posterior foraminotomy was performed at these levels, and the patient experienced relief of symptoms. The second patient underwent a C5–6 ACD with immediate relief of symptoms and radiographic evidence of successful fusion; she gradually became symptomatic again and underwent C4–5 and C6–7 ACDF 8 years after her initial operation, with good results. The third patient underwent a C6–7 ACDF and complained of worsened pain following surgery. He partially improved and developed radiographic fusion. At 18 months, a C6–7 posterior foraminotomy was performed, and the patient experienced symptomatic relief.

**Table 1**

<table>
<thead>
<tr>
<th>Type of Complication</th>
<th>ACD (44 patients)</th>
<th>ACDF (40 patients)</th>
<th>( p ) Value</th>
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<tr>
<td>Medical†</td>
<td>4</td>
<td>10</td>
<td>&lt;0.05</td>
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<tr>
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<td></td>
<td></td>
<td>not significant</td>
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<tr>
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<tr>
<td>Numbness</td>
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<td>2</td>
<td></td>
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<tr>
<td>Total</td>
<td>3</td>
<td>5</td>
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* Including atelectasis, urinary tract infection, and leukocytosis.
† All deficits were transient and resolved by the first office visit.

**Discussion**

Cervical spondylosis is a common condition recognized as a major cause of arm and neck pain. Dysfunction at the level of the intervertebral disc and joint complex is the earliest form of the disorder, and it may occur in response to a specific injury or as a result of cumulative wear and tear of an active lifestyle. Hypertrophy of the support-
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Fusioning tissues occurs in response to this subtle instability. This is a heterogeneous response with ligamentous hypertrophy, joint narrowing, reactive growth from the bony endplates, and calcification of the joint capsule. These changes perform the teleologically useful function of stabilizing worn joints with an osseous bridge or autofusion of that joint space. However, the proximity of neurological structures to the affected joint complexes may result in adverse consequences. This is often the case in the cervical spine in which joint narrowing, ligamentous thickening, and bone spurs can cause compression at the root level (radiculopathy) or the spinal cord level (myelopathy).

The relative importance of each pathological process will vary among patients, and as such, treatment strategies need to be tailored to match the specific changes present in a given patient. Nonoperative therapy may be successful in cases of mild nerve root inflammation. However, patients with true mechanical compression of neurological structures often require surgical intervention.

Both anterior and posterior approaches have been used for the treatment of this condition. However, incomplete recovery from disease situated anterior to the spinal cord has been found following posterior decompression alone. Whereas the treatment of radiculopathy is largely successful with either approach, the anterior approach offers maximum exposure for disease centered around the disc space. Following decompression of the involved neurological structures, many authors favor the use of a fusion procedure. Arguments in favor of this approach include the maintenance of disc space height, which avoids vertebral settling and minimizes the potential for developing foraminal stenosis. Additionally, fusion will remove the instability component of the disorder, which may cause progressive deterioration.

The necessity of adding a fusion procedure is not universally accepted. In the cervical area, a fusion procedure poses its own set of complications in addition to those of ACD alone. Most obvious are autogenous donor-site complications such as hematoma and neurological injury to the lateral femoral cutaneous nerve (maligna parasthetica). Patients often complain of more pain in this area than at the cervical surgical site. The use of allograft material has the potential for transmission of viral particles and other infectious agents. Placing the graft in the recipient site may entail further neck dissection for exposure than discectomy alone. Late complications of cervical fusion include graft extrusion that causes spinal cord injury or dysphagia.

The results of this study suggest that a fusion procedure adds little to the ACD alone in the surgical management of cervical spondylosis at one or two levels. The operative time was significantly longer for ACDF patients, they experienced more pain immediately following surgery, and they required more analgesic medications. The medical complications encountered were mild but significantly greater in the ACDF group. The hospital stay was also significantly prolonged.

As expected, the rate of successful fusion was statistically different between groups. The ACDF group had a 97% fusion rate compared with 70% in the ACD group. Connolly, et al., found that when using cine radiographs, motion was detectable at operative levels that appeared fused on plain x-ray films. Fusion has been evaluated in a goat model in which histological investigations found only 25% osseous union in levels exhibiting radiographic fusion. This suggests that bone fusion is poorly evaluated by radiographic measures and may be inappropriate as an endpoint. A better goal is relief of symptoms and patient satisfaction, which was well achieved in both ACD and ACDF groups.

Other investigators have examined the relative merits of ACD alone and with the addition of a fusion procedure. Only two studies had a prospective, randomized design comparing ACD and ACDF. The study by Pati, with all procedures either performed or supervised by a single surgeon, is similar to the present report. He found that although the operative time for ACD was decreased, patient discomfort, the length of hospital stay, and patient satisfaction (at 10 months) were similar between groups. He believed that both operations were “equally safe and effective” and could be used “interchangeably.” No long-term follow up was reported in this series. Rosenorn and colleagues described a series of patients with herniated cervical disc disease in whom five surgeons performed the surgeries. Patients undergoing ACD had a significantly greater return to work for the first 9 weeks and superior clinical outcome at 3 months. By 12 months, the results of the two procedures were similar. This is especially significant considering that cadaveric donor bone was utilized for fusion procedures in that series. Long-term follow up was not reported.

The strength of this study lies with the randomized, prospective design, a reasonably uniform diagnostic category (cervical spondylosis), and involvement of a single surgeon. In addition, an average follow-up period of 4.5 years (range 1.5–8 years) is the longest for any study of this type. However, cervical spondylosis is a progressive condition and a longer follow-up period may demonstrate differences between the two procedures.
ditionally, the study size may have have masked other differences that would prove significant in a larger group.

Conclusions

The results of the study demonstrate a distinct difference in early patient satisfaction. Operative times were shorter, postoperative pain relief was greater, and postoperative analgesia requirements were less in the ACD group. This resulted in a decreased length of hospitalization in the ACD group. As expected the rate of successful fusion was greater for the ACDF group. However, this did not correlate with an improved level of satisfaction with the procedure or less long-term pain. This would suggest that the addition of a fusion procedure is not absolutely necessary. Procedure selection should be at the discretion of the surgeon and based on individual patient factors.

References


Addendum

While this article was in press, Savolainen, et al., (Neurosurgery 43:51–55, 1998) published results of a similar study performed in Finland. Patients with cervical radiculopathy from single-level disc disease were prospectively randomized to groups undergoing simple discectomy, discectomy with fusion, and discectomy with fusion and anterior plate placement. Clinical outcomes were satisfactory and similar among groups. Based on their results, these authors recommend simple discectomy as the procedure of choice for this condition.

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