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Clinical Study

# Outcomes of single-level cervical disc arthroplasty versus anterior cervical discectomy and fusion

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ABSTRACT

Several studies have established the short-term safety and efficacy of cervical disc arthroplasty (CDA) as compared to anterior cervical discectomy and fusion (ACDF). However, few single-center comparative trials have been performed, and current studies do not contain large numbers of patients. We retrospectively reviewed all patients from a single military tertiary medical center between August 2008 to August 2012 who underwent single-level CDA or single-level ACDF and compared their clinical outcomes and complications. A total of 259 consecutive patients were included in the study, 171 patients in the CDA group with an average follow-up of 9.8 (±9.9) months and 88 patients in the ACDF group with an average follow-up of 11.8 (±9.6) months. Relief of pre-operative symptoms was 90.1% in the CDA group and 86.4% in the ACDF group with rates of return to full pre-operative activity of 93.0% and 88.6%, respectively. Patients who underwent CDA had a higher rate of persistent posterior neck pain (15.8% *versus* 12.5%), and patients who underwent ACDF were at risk for symptomatic pseudarthrosis at a rate of 3.4%. Reoperation rates were higher in the ACDF group (5.7% *versus* 3.5%). To our knowledge, this review is the largest, non-funded, comparison study between single-level CDA and single-level ACDF. This study demonstrates that CDA is a safe and reliable alternative to ACDF in the treatment of cervical radiculopathy and myelopathy resulting from spondylosis and acute disc herniation.

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## 1. Introduction

Cervical disc arthroplasty (CDA) has been espoused as a safe, segmental motion-sparing alternative to anterior cervical discectomy and fusion (ACDF) in the treatment of cervical radiculopathy and myelopathy resulting from spondylosis and acute disc herniation. Although ACDF is the current standard for treatment of cervical radiculopathy and myelopathy, concerns exist over symptomatic adjacent-segment disc degeneration [1,2]. Furthermore, cadaver studies have demonstrated increased motion and intra-discal pressures adjacent to cervical fusion levels [3,4]. These concerns have led to the development and use of several cervical disc arthroplasty systems. Anticipated benefits of CDA include maintaining alignment and motion as well as decreasing stress on the adjacent-level disc, which may decrease symptomatic adjacent-level disc degeneration [5]. General indications for CDA include reconstruction after neural decompression of disc herniation or foraminal osteophytes causing radiculopathy or myelopathy. Contraindications include deformity, immobile segments, instability, and facet joint degeneration. Relative contraindications include rheumatoid arthritis, renal failure, osteoporosis, cancer, and pre-operative corticosteroids [6,7].

Short-term results from several small randomized controlled trials demonstrated that CDA was associated with better overall success, better neurologic success, and fewer revision procedures [8–12]. However, there are few single center comparison studies and current studies do not contain large numbers of patients. Based on our experience with CDA, we performed a review comparing outcomes and complications in patients undergoing single-level CDA and single-level ACDF at a single institution.

## 2. Materials and methods

Following approval from our Institutional Review Board, the surgical database at our institution was queried to identify all

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patients who had undergone single-level CDA or single-level ACDF between August 2008 and August 2012. Seven surgeons (five neurological surgeons and two spine fellowship trained orthopedic surgeons) were the primary surgeon performing the respective procedure. The search yielded 180 CDA patients and 95 ACDF patients. In the CDA group, nine patients were lost to follow-up and seven patients in the ACDF group were also lost to follow-up, which left 259 total patients (171 in the CDA group and 88 in the ACDF group) for review. Both groups included patients undergoing primary and revision surgery. All data were collected via a retrospective chart analysis, which included inpatient and outpatient clinical notes, surgical databases, and radiographs, which was subsequently analyzed by independent researchers. Data collected include patient demographic information (age, sex, tobacco use, body mass index [BMI]), patient-centered outcomes (complete relief of pre-operative symptoms, relief of pre-operative neurologic symptoms, return to pre-operative level of activity, return to active duty for patients in the military), and complications (incidence of persistent post-operative posterior neck pain, recurrent laryngeal nerve injury, persistent dysphagia, post-operative respiratory compromise, esophageal/tracheal disruption, implant failure, adjacent segment degeneration, intra-operative fracture, dural tear, nerve root injury). Persistent posterior neck pain and dysphagia were defined in the study as symptoms lasting longer than 3 months in the post-operative period or requiring secondary intervention.

## 3. Results

In the CDA group, there were 134 males (78.4%) and 37 females (21.6%) with an average age of 40.5 years (standard deviation 8.3). In the ACDF group, there were 65 males (73.9%) and 23 females (26.1%) and the average age was 47.5 (±12.4) years. The average follow-up was 9.8 (±9.9) months and 11.8 (standard deviation 9.6) months for the CDA and ACDF groups, respectively. The average BMI was 27.8 (standard deviation 3.8) kg/m$^2$ for CDA patients and 28.9 (standard deviation 5.7) kg/m$^2$ for ACDF patients. Tobacco use was higher in the CDA group at 28.1% (132 patients) compared to the ACDF group at 17.0% (15 patients). Revision surgery was more common in the ACDF group than the CDA group (23.9% *versus* 4.7%). In the CDA group, 132 patients (77.2%) were on active duty in the military at the time of surgery compared to only 40 patients (45.5%) in the ACDF group.

The primary indication for CDA was radiculopathy in 154 patients (90.1%). Other indications included myelopathy (1.8%), myelo-radiculopathy (5.8%), and neck pain (2.3%). In the ACDF group, the primary indication for surgery was radiculopathy in only 63.6% of patients and myelopathy in 18.2% of patients. Other indications included myelo-radiculopathy (5.7%), neck pain (5.7%), trauma (3.4%), and pseudoarthrosis (3.4%). The most common levels addressed at the time of surgery in the CDA group were C6–7 followed by C5–6 (50.9% and 38.0%, respectively). In the ACDF cohort, the most common levels of disease were C5–6 and C6–7 (44.3% and 23.9%, respectively). Levels C3–4 and C4–5 were commonly involved in the ACDF group (13.6% and 15.9% respectively) as compared to the CDA group (2.3% and 8.2%, respectively). One patient underwent ACDF at C2–3 and one patient in each group had surgery at C7–T1 (Table 1).

The Prestige (Medtronic, Memphis, TN, USA) cervical arthroplasty system was utilized in the majority of patients (94.7%), while the ProDisc-C system (DePuy Synthes, Paoli, PA, USA) was utilized in the remainder of patients (5.3%). The most common surgical implant used in the ACDF group was the traditional anterior cervical plate and interbody spacer (78.4%). Other implants included the stand alone integrated spacer in 11.4% of patients and a spacer-only construct in 10.2% of ACDF patients (Table 2).

**Table 1**
Cervical disc arthroplasty and anterior cervical discectomy and fusion baseline demographic information, disease levels and indications for surgery

| | CDA | ACDF |
|---|---|---|
| Total patients, n | 171 | 88 |
| Males | 134 (78.4%) | 65 (73.9%) |
| Females | 37 (21.6%) | 23 (26.1%) |
| Age (mean ± SD) | 40.5 ± 8.3 years | 47.5 ± 12.4 years |
| BMI (mean ± SD) | 27.8 ± 3.8 kg/m$^2$ | 28.9 ± 5.7 kg/m$^2$ |
| Tobacco use | 48 (28.1%) | 15 (17.0%) |
| Active duty military | 132 (77.2%) | 40 (45.5%) |
| Revision surgery | 8 (4.7%) | 21 (23.9%) |
| Average follow-up (mean ± SD) | 9.8 ± 9.9 months | 11.8 ± 9.6 months |
| Levels of disease | | |
| C2–3 | 0 | 1 (1.1%) |
| C3–4 | 4 (2.3%) | 12 (13.6%) |
| C4–5 | 14 (8.2%) | 14 (15.9%) |
| C5–6 | 65 (38.0%) | 39 (44.3%) |
| C6–7 | 87 (50.9%) | 21 (23.9%) |
| C7–T1 | 1 (0.6%) | 1 (1.1%) |
| Primary indication for surgery | | |
| Myelopathy | 3 (1.8%) | 16 (18.2%) |
| Radiculopathy | 154 (90.1%) | 56 (63.6%) |
| Myelo-radiculopathy | 10 (5.8%) | 5 (5.7%) |
| Neck pain | 4 (2.3%) | 5 (5.7%) |
| Trauma | N/A | 3 (3.4%) |
| Pseudoarthrosis | N/A | 3 (3.4%) |

Data are presented as number (%) unless otherwise stated.
ACDF = anterior cervical discectomy and fusion, BMI = body mass index, CDA = cervical disc arthroplasty, N/A = not applicable, SD = standard deviation.

**Table 2**
Surgical data for cervical disc arthroplasty and anterior cervical discectomy and fusion groups

| Surgical implant | CDA | ACDF |
|---|---|---|
| Prestige[a] | 162 (94.7%) | N/A |
| Pro-Disc C[b] | 9 (5.3%) | N/A |
| Anterior plate/spacer | 0 | 69 (78.4%) |
| Stand alone integrated spacer | 0 | 10 (11.4%) |
| Spacer only | 0 | 9 (10.2%) |

None of the CDA patients received spacers or anterior plates, as these techniques were only applicable to fusion patients.
[a] Medtronic, Memphis, TN, USA.
[b] DePuy Synthes, Paoli, PA, USA.
ACDF = anterior cervical discectomy and fusion, CDA = cervical disc arthroplasty, N/A = not applicable.

Out of the 171 patients in the CDA group, 157 (91.8%) experienced complete relief of pre-operative neurologic symptoms and 154 patients (90.1%) had complete post-operative symptomatic relief. In the ACDF group, 78 (88.6%) patients had post-operative relief of neurologic symptoms and 76 (86.4%) patients had complete relief of all pre-operative symptoms. Seventeen patients (9.9%) in the CDA group and 12 patients in the ACDF group (13.6%) had incomplete relief of pre-operative symptoms. These patients had persistent posterior neck pain, continued radiculopathy, continued myelopathy, or a combination of the aforementioned symptoms. In both groups, a vast majority of patients were able to return to their pre-operative level of activity (93.0% in the CDA group and 88.6% in the ACDF group. In the active duty military population, 92.4% of patients in the CDA and 84.0% of patients were able to return to active duty after surgery (Table 3).

Persistent posterior neck pain was observed post-operatively in both cohorts at rates of 15.4% (27 patients) in the CDA group and 12.5% (11 patients) in the ACDF group. Twenty patients (74.1%) in the CDA group who experienced persistent posterior neck pain post-operatively eventually had resolution of their symptoms without intervention at the last recorded follow-up appointment.