

Outcomes Following Cervical Disc Arthroplasty in an Active Duty Military Population

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Symptomatic cervical radiculopathy is a common problem in the active duty military population and can cause significant disability leading to limited duty status and loss of operational readiness and strength. Based on their increasing experience with cervical disc arthroplasty (CDA) in this unique patient population, the authors set out to further evaluate the outcomes and complications of CDA in active duty military patients. A retrospective review of a single military tertiary medical center was performed between August 2008 and August 2012 and the clinical outcomes of patients who underwent cervical disc arthroplasty were evaluated. There were 37 active duty military patients, with a total of 41 CDA. The study found good relief of preoperative symptoms (92%) and the ability to maintain operational readiness with a high rate of return to full unrestricted duty (95%) with an average follow-up of 6 months. There was a low rate of complications related to the anterior cervical approach (5%–8%), with no device- or implant-related complications. (Journal of Surgical Orthopaedic Advances 22(1):10–15, 2013)

Key words: active duty military, cervical disc arthroplasty, cervical disc replacement, degenerative disc disease, radiculopathy, return to duty

Symptomatic cervical degenerative disc disease is a common problem in society (1, 2) and the prevalence of cervical radiculopathy seems to be just as common within the United States (U.S.) active duty military population (3). Schoenfeld et al. (3) found that the U.S. military had an increased risk for development of cervical radiculopathy with increasing age, female sex, white race, and senior positions within the rank structure. Cervical radiculopathy may result from a number of etiologies,

including cervical intervertebral disc herniation, spondylosis, or instability. This can present with a constellation of symptoms, such as radiating pain or paresthesias along the distribution of a cervical nerve root, motor weakness, and/or diminished reflexes (3–7). These symptoms can be quite disabling and, in the civilian population, can result in substantial time off from work, lost wages, and decreased productivity. Similarly in the military, cervical radiculopathy often results in service members being placed on limited or restricted duties and can potentially affect the operational readiness of a unit, particularly for service members with specialized skills and duties. This may be even more detrimental for smaller, highly trained special operations units that require vigorous levels of physical readiness and high-impact activities. Although all surgeons seek optimal outcomes to allow patients to return as contributing members of society, military spine surgeons are faced with a unique mission to maintain the fighting and operational strength of the armed forces protecting our national security.

Once nonoperative measures have been exhausted, operative treatment may be necessary to allow the patient to return to his or her previous level of activity. However, controversy remains regarding the optimal operative treatment and approach, and there has been an increasing popularity of motion preservation surgeries for the treatment of spinal pathologies. In 2007 the U.S. Food and Drug Administration (FDA) approved the use of cervical disc

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arthroplasty (CDA) devices for the treatment of single-level cervical radiculopathy, and subsequent Investigational Device Exemption (IDE) trials using various CDA devices have established their safety and noninferiority to anterior cervical discectomy and fusion (ACDF) (8–12). To our knowledge, there has been only one other study to date evaluating the outcomes of cervical disc arthroplasty in the military active duty population (13) and there continues to be limited information regarding restrictions, limitations, and level of physical activity in the postoperative period. Therefore, based on our increasing experience with CDA in this unique patient population, we set out to further evaluate the outcomes and complications of CDA in active duty military patients.

Materials and Methods

The surgical database at our institution was queried to identify all patients who had undergone cervical disc arthroplasty by the orthopaedic spine surgery service between August 1, 2008 and August 1, 2012. This search yielded 37 total active duty military personnel involving all services (i.e., Army, Air Force, Marines, Navy). All construct types (single-level CDA, hybrid, and multilevel CDA) were included for review. After institutional review board approval was obtained, data were collected via a retrospective chart review, which included inpatient and outpatient clinical notes, surgical databases, and radiographs. Data collected include patient demographic information [age, sex, tobacco use, body mass index (BMI)], operative information (surgical time, intraoperative complications), patient-centered outcomes (relief of preoperative symptoms, incidence and resolution of posterior neck pain in the postoperative period, return to full unrestricted duty), complications (recurrent laryngeal nerve injury, dysphagia, postoperative respiratory compromise, esophageal and tracheal disruption), and radiographic parameters (increase in disc height, segment range of motion, evidence of loosening, migration, or subsidence).

Results

Of the 37 patients studied, only two were female (5%), three admitted to using tobacco products (8%), and the average BMI was 27.4. The average age was 37.2 years. Of the 37 patients, 20 underwent cervical disc arthroplasty utilizing the Prestige system (Medtronic, Memphis, TN) and 17 had Prodisc-C implants (DepuySynthes, Paoli, PA), with a total of 41 CDAs performed. C5–6 was the most commonly degenerated level (68%), followed by C6–7 (57%) and C4–5 (19%). C5–6 and C6–7 degenerative disease was addressed concomitantly in 32% of

patients (Table 1). Single-level CDA was performed in 22 patients (60%) with the remaining constructs being hybrid or multilevel CDA (32% and 11%, respectively). The average operative time for single-level cases was 117 (± 27) minutes and for two-level cases was 151 (± 33) minutes. One patient had been previously treated with an ACDF and demonstrated symptomatic adjacent segment degeneration (ASD) and subsequently underwent CDA. The surgical indication in all patients reviewed was symptomatic radiculopathy. No patients in this study demonstrated preoperative myelopathy or myeloradiculopathy.

Both preoperative and postoperative films were available for all but one patient for review (97%). Postoperative flexion and extension cervical spine films were obtained in 31/37 patients (84%). Following CDA, the average increase in cervical disc space was 2.6 mm (± 1.3 mm) and the average maximum segment range of motion in flexion and extension was 9.2° ($\pm 3.4^\circ$). There was no evidence of loosening, migration, subsidence, or heterotopic ossification on follow-up radiographs.

The average length of follow-up was 6.8 months (range, 1–22 months). At the time of most recent follow-up, 92% of patients demonstrated relief of preoperative symptoms (radicular pain, weakness) (Table 2). Of the three patients who did not experience complete relief of symptoms, one underwent posterior foraminotomies at 8 months because of persistent weakness and was subsequently cleared to deploy with his unit at 10 months, and the other two were lost to follow-up at 2 and 7 months. Also following restoration of intervertebral height and subsequent tensioning of the posterior elements, some patients experienced the sequela of postoperative posterior neck pain, with 24% of patients (9/37) having persistent symptoms at their most recent follow-up. However, of

TABLE 1 Demographic information

Males	35
Females	2
Average age	37.2 \pm 6.2 years
Average body mass index (BMI)	27.4 \pm 3.7
Tobacco use	8%
Average follow-up	6.8 \pm 5.0 months
Disease level	
C4–5	19%
C5–6	68%
C6–7	57%

TABLE 2 Overall patient outcomes and complications

Complete resolution of preoperative symptoms	92%
Full return to active duty	95%
Posterior neck pain at most recent follow-up	24%
Posterior neck pain beyond 6 months	11%
Recurrent laryngeal nerve injury	5%
Dysphagia	8%

TABLE 3 Patient outcomes and complications by construct type

	1-Level CDA	2-Level Hybrid	3-Level Hybrid	2-Level CDA
No. of patients (% total)	22 (60%)	11 (30%)	1 (3%)	3 (11%)
Complete resolution of preoperative symptoms	95%	82%	100%	100%
Full return to active duty	95%	91%	100%	100%
Posterior neck pain at most recent follow-up	23%	36%	0%	0%
Posterior neck pain beyond 6 months	14%	9%	0%	0%
Recurrent laryngeal nerve injury	9%	0%	0%	0%
Dysphagia	5%	18%	0%	0%

these patients, only four (11%) had documented posterior neck pain beyond 6 months; the other patients did not have follow-up beyond 3 months and no patients had preoperative posterior neck pain. No patients required narcotic medication for pain relief at their most recent follow-up and all but one were able to return to active duty regardless of their neck pain. There were similar clinical results between different construct types (Table 3).

Dysphagia was documented in 8% (3/37) of patients in the postoperative period. Of the three patients, one reported nearly complete resolution by 6 months and complete resolution at 12 months; another reported persistent dysphagia at 7 months and was lost to follow-up; the last patient reported dysphagia at time of final follow-up (8 months), but was cleared to deploy at 10 months postoperatively.

Of note, two patients demonstrated both persistent dysphagia >6 months' duration and incomplete resolution of symptoms. One patient was lost to follow-up after referral to pain management and electromyographic and nerve conduction studies, and one underwent posterior foraminotomies at 8 months and was lost to follow-up but was cleared to deploy by his primary care provider at 10 months.

Two out of 37 patients (5%) sustained right-sided recurrent laryngeal nerve palsies. Both were treated subsequently by otolaryngology specialists; one patient demonstrated complete return of right vocal cord function at 7 months; the other required medialization laryngoplasty and never regained right laryngeal nerve function.

Discussion

To our knowledge, this is the largest retrospective review of cervical disc arthroplasty in an active duty military population. Our results demonstrate a 92% rate of preoperative symptom relief and maintenance of approximately 9.2° of segmental motion with CDA. Furthermore, there was a low complication rate with regard to persistent postoperative dysphagia (8%) and recurrent laryngeal nerve injury (5%). Postoperative posterior neck pain was persistent (>6 months) in 11% of patients, and only one patient with this sequela had not yet returned to active

duty at the time of his latest follow-up (2 months). In our continued experience we have found that most patients have complete relief of posterior neck pain by 3 months.

Our rate of dysphagia was lower (8%) than the rate reported throughout the literature (28%–57%) (14–18). This may be because dysphagia is frequently underreported clinically (15) and our patient cohort was at a lower risk in general for this complication; they are younger in age (18), predominantly male (17), and were not undergoing revision surgery (17).

Spinal fusion continues to be the most common surgical treatment for cervical radiculopathy and other degenerative conditions in the neck (19–22). Although fusion has been similarly used for treatment of arthritic conditions of large articular joints such as the hip, knee, and shoulder, it has been replaced by revolutionary joint arthroplasty techniques with excellent outcomes in relieving pain and restoring function (23, 24). In contrast, disc arthroplasty has only recently been considered an alternative to spinal arthrodesis and has not replaced fusion as the “gold standard” treatment. A particular concern following spinal arthrodesis has been the failure to restore normal physiologic motion, possibly leading to an increase in adjacent segment degeneration and disease (25–27). Spine biomechanics have been found to be significantly altered following arthrodesis, which includes loss of motion and shock absorption, subsequently causing compensatory increased motion and intradiscal pressure at adjacent segments (28–33). Although adjacent segment degeneration and disease may be caused by natural disease progression, rather than a consequence of spinal arthrodesis, there has been continued enthusiasm and advancement of motion restoration surgeries (23). This represents a potential paradigm shift in the approach from motion elimination surgery to motion-preserving surgery, with the underlying hypothesis that motion preservation at the treated symptomatic degenerative disc may slow progression or even prevent symptomatic degeneration at adjacent segments (34).

Motion preservation using CDA devices for treatment of cervical radiculopathy has gained interest among military spine surgeons, particularly with the imperative responsibility to maintain operational strength and readiness by returning service members as quickly and safely

as possible to full unrestricted duty. Large, multicenter prospective FDA IDE trials have demonstrated CDA to be safe and at least equivalent to arthrodesis in the civilian population (8–12, 35, 36). There have also been two level II studies that have evaluated the length of time to return to work for patients treated with CDA compared with ACDF, and both found arthroplasty patients returned to work significantly sooner (range, 14–16 days sooner) (10, 35). Tumialán et al. (13) in 2010 performed a retrospective review of 12 active duty CDA patients, and all were able to return to full unrestricted military duty at an average of 10.3 weeks (range, 7–13 weeks), which was significantly shorter than the average of 16.5 weeks for fusion patients (13). The authors concluded that CDA is comparable with arthrodesis and may actually expedite return to active duty, allowing patients to return to a high level of rigorous training and physical performance without restrictions at 3 months postoperatively (13). In our study we had nearly 95% of patients return to full unrestricted duty with an average follow-up of 6 months, with no patients separated from the military for persistent symptoms.

Our group also performed two-level CDA in 11% and hybrid construct in 32% of patients with multilevel disease. The use of multilevel CDA and CDA in the setting of a hybrid construct has been previously found to be a safe and effective alternative to fusion for the management for multilevel cervical disease (14, 37–40). However, the use of a multilevel CDA construct or CDA adjacent to a fusion construct has not been evaluated through FDA trials and remains a physician-directed use of the device. The decision regarding which level would receive arthroplasty versus fusion in patients with multilevel disease was based on performing arthroplasty adjacent to the level that would most likely experience adjacent segment degeneration (i.e., C4–6 disease would undergo C4–5 ACDF and C5–6 CDA, because C6–7 is more likely to progress to a diseased state compared to C3–4). Patients with noncontiguous multilevel disease (i.e., C4–5 and C6–7) were given the option of CDA at each level. Patients in our series with multilevel CDA and hybrid constructs had good results with excellent relief of symptoms (82%–100%), return to duty (91%–100%), and a low rate of complications (0%–18%).

Postoperative recommendations following CDA for return to physical activities, sports, and heavy labor still remain unclear for civilian patients, with even less information available to guide the military spine surgeon tasked with caring for a unique patient population with requirements for rigorous levels of activity and physical performance. Based on our growing experience with CDA in an active duty military population, if all preoperative symptoms have resolved, we allow return to light impact and cardio activities, weight training, and running

immediately after surgery, with return to full unrestricted duty at 6 weeks postoperatively. In our series, which is the largest to date, we had no catastrophic complications or device failures, despite return to activities that place extraordinary physiologic stresses on the cervical spine, such as parachute jumping (static line and high-altitude free fall), high-impact water entries, hand-to-hand combat, and prolonged running carrying heavy loads (13). The long-term wear characteristics and longevity of CDA devices also remains unknown, and it is uncertain whether repetitive axial load and rotational stresses from high-impact military activities will ultimately affect long-term implant survivability. The military spine surgeon must also take into account the significant differences in design and biomechanical properties of various CDA devices, although the potential implications on the immediate and long-term behavior of the implant remain unknown. For example, the Prestige (Medtronic, Memphis, TN) CDA device has immediate fixation with a screw and plate construct and is a metal-on-metal bearing surface, whereas the ProDisc-C (DepuySynthes, Paoli, PA) device has a press-fit fixation using midline keels and is a metal-on-polyethylene bearing surface (41–43).

A few potential weaknesses of this study include variable follow-up rates and lack of a comparison group. At our facility, it is common to have patients travel long distances for surgery, return for a follow-up appointment, then arrange follow-up elsewhere. Some patients who had complaints at their first follow-up appointment were lost to follow-up, although they were able to return to active duty. We included their complaints (incomplete resolution of symptoms, persistent neck pain, dysphagia, etc.) in our final data analysis, even though there is the potential that their symptoms would have resolved. We also included a patient approximately 2 years postoperatively with only one documented follow-up at 1 month, and despite this short-term follow-up there was complete relief of preoperative symptoms and no complications, and he was subsequently cleared for deployment and then lost to follow-up. With regard to the lack of a comparison group, a large number of our patients underwent multilevel surgery, often with hybrid constructs (14, 37). It would have been very difficult to control for these patients, and that was not the goal of this study. Future studies should evaluate the cost-effectiveness of CDA, given the increased cost of this new technology, which may be balanced out by reduced indirect cost through improved time to return to work, as well as the potential for long-term cost benefits through decreased reoperation rates because of pseudarthrosis or adjacent segment disease, although this has not yet been established in ongoing clinical trials. We are also planning a prospective observational study comparing the long-term outcomes and survivability of CDA compared to ACDF in the military population.

In conclusion, our continued experience with cervical disc arthroplasty in an active duty military population demonstrates good relief of preoperative symptoms (92%) and the ability to maintain operational readiness with a high rate of return to full unrestricted duty (95%) with an average follow-up of 6 months. There was a low rate of complications related to the anterior cervical approach (5%–8%), with no device- or implant-related complications. This is similar to a previous report on the use of CDA in military patients and may allow the military spine surgeon to minimize time from surgery until return to full unrestricted duty.

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