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Research Article

Clinical Outcomes After Cervical Disc Arthroplasty Versus Zero-Profile Interbody Fusion for Single-Level Cervical Degenerative Disc Disease: A Prospective Comparative Study

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ABSTRACT

Objective: To prospectively compare clinical outcomes of cervical disc arthroplasty (CAD) and zero-profile interbody fusion (Zero-P) in patients undergoing surgery for single-level cervical degenerative disc disease.
Methods: This prospective observational study included 50 patients treated surgically for single-level cervical degenerative disc disease between August 2023 and May 2025. Patients underwent either cervical disc arthroplasty (n = 25) or zero-profile interbody fusion (n = 25). Clinical outcomes were assessed preoperatively and at 1, 3, and 6 months and 1 year postoperatively using the visual analog scale (VAS) for pain, Neck Disability Index (NDI), and Japanese Orthopaedic Association (JOA) score. Operative time, estimated blood loss, subsequent surgical intervention, and adjacent segment disease were recorded. Between-group comparisons were performed using Student's t-test and the chi-square test, with statistical significance set at $p < 0.05$.
Results: Baseline demographic and clinical characteristics were comparable between groups. Operative time and blood loss did not differ significantly. Both groups demonstrated significant improvement in VAS and NDI scores over time. VAS scores were significantly lower in the CAD group from 3 months through 1 year postoperatively ($p < 0.05$). NDI scores differed between groups at 3 and 6 months but were similar at 1 year. JOA scores did not differ significantly between groups at baseline or at 1-year follow-up. Subsequent surgical intervention occurred in 1 patient (4%) in the CAD group and 2 patients (8%) in the Zero-P group ($p = 1.00$). Adjacent segment disease was identified in 1 CAD patient and 3 Zero-P patients ($p = 0.60$).
Conclusion: Both cervical disc arthroplasty and zero-profile interbody fusion resulted in significant improvement in pain, functional status, and neurological outcomes in patients with single-level cervical degenerative disc disease. Cervical disc arthroplasty was associated with superior intermediate-term pain relief, while functional and neurological outcomes and early complication rates were comparable between procedures. Careful patient selection remains essential, and longer-term follow-up is required to assess sustained clinical and radiographic outcomes.

Keywords*: cervical disc arthroplasty, zero-profile interbody fusion, cervical degenerative disc disease, neck disability index, visual analog scale.*

INTRODUCTION

Cervical degenerative disc disease is a common cause of neck pain and radiculopathy in adults. When conservative treatment fails, surgical intervention is often required. Anterior cervical discectomy and fusion (ACDF) has long been considered the standard surgical treatment for single-level disease. Clinical outcomes after ACDF are generally favorable. However, concerns remain regarding loss of motion at the index level and the potential development of adjacent segment disease.

Cervical disc arthroplasty was developed to preserve segmental motion while achieving adequate neural decompression. Motion preservation surgery aims to reduce biomechanical stress at adjacent levels. Long-term results from Food and Drug Administration trials have shown that cervical disc arthroplasty provides durable clinical improvement. The ProDisc-C investigational device study demonstrated sustained pain relief and functional improvement at five years, with outcomes comparable or superior to ACDF in selected patients [1]. These findings supported the expanded use of arthroplasty for single-level symptomatic cervical degenerative disc disease.

Reoperation rates and adjacent-level pathology remain key considerations when comparing arthroplasty and fusion. Meta-analytic evidence suggests that cervical disc arthroplasty is associated with fewer reoperations at both index and adjacent levels when compared with ACDF. Zhong and colleagues reported significantly lower overall reoperation rates after arthroplasty, with reductions observed at both the operated and adjacent segments [2]. These findings support the theoretical advantage of motion preservation in reducing secondary surgical intervention.

Despite these advantages, fusion techniques have continued to evolve. Zero-profile interbody fusion devices were introduced to address complications associated with anterior cervical plates, particularly postoperative dysphagia. These devices allow stable fixation while minimizing anterior soft tissue irritation. Clinical studies have demonstrated the safety and feasibility of zero-profile constructs, with acceptable alignment and favorable clinical outcomes [4]. As a result, zero-profile fusion has become a widely used alternative to traditional plated ACDF.

Adjacent segment disease remains a multifactorial process. Long-term follow-up studies of cervical fusion patients demonstrate that radiographic and symptomatic degeneration can occur over time. Alhashash et al. reported adjacent segment disease in long-term follow-up after cervical fusion, highlighting the influence of altered biomechanics and natural disease progression [5]. Whether motion preservation reliably reduces this risk remains an area of ongoing investigation.

Although numerous studies have compared cervical disc arthroplasty with conventional fusion, direct comparisons between arthroplasty and zero-profile fusion devices remain limited. Given the increasing use of both techniques in contemporary practice, further comparative clinical data are needed. The present study prospectively compares clinical outcomes, pain relief, neurological recovery, and early complication profiles between cervical disc arthroplasty and zero-profile interbody fusion in patients with single-level cervical degenerative disc disease.

AIM

To prospectively compare clinical outcomes of cervical disc arthroplasty and zero-profile interbody fusion in patients undergoing surgery for single-level cervical degenerative disc disease.

Objectives

1. To compare clinical outcomes between cervical disc arthroplasty and zero-profile interbody fusion by evaluating postoperative pain (VAS), functional disability (NDI), and neurological status (JOA).
2. To assess perioperative and short-term safety outcomes of both procedures by comparing operative time, blood loss, need for subsequent surgical intervention, and early incidence of adjacent segment disease.
3. To evaluate the overall effectiveness of cervical disc arthroplasty relative to zero-profile interbody fusion in the management of single-level cervical degenerative disc disease during short- and intermediate-term follow-up.

METHODS

Study design and setting

We conducted a single-center, prospective observational comparative study at the Department of Neurosurgery, Bangur Institute of Neurosciences, IPGMER & SSKM Hospital, Kolkata, between August 2023 and May 2025. Patients undergoing single-level anterior cervical surgery were enrolled into 2 treatment cohorts: cervical artificial disc arthroplasty (CAD) and zero-profile interbody fusion (Zero-P).

Patient selection

Adult patients with symptomatic single-level cervical degenerative disc disease were eligible. Indications included cervical radiculopathy attributable to disc herniation and/or degenerative cervical spinal stenosis with failure of conservative treatment for at least 3 months.

Key exclusion criteria were severe facet degeneration (bridging osteophytes, > 50% disc height loss, or intervertebral motion < 2°), developmental cervical canal stenosis, ossification of the posterior longitudinal ligament, radiographic instability (angular displacement > 2° or translation > 2 mm), osteoporosis or compression fracture, congenital cervical abnormalities, tumor, infection, ankylosing spondylitis, and prior cervical surgery. Patients with radiographic evidence of adjacent-level degeneration were excluded.

A total of 50 patients were included: CAD (n = 25) and Zero-P (n = 25). Treatment allocation was nonrandomized.

Surgical technique

All procedures were performed using a standard left-sided anterior cervical approach. After discectomy, the posterior longitudinal ligament was removed. In the fusion cohort, a zero-profile interbody device was placed at the index level according to appropriate sizing. In the arthroplasty cohort, a cervical disc prosthesis was implanted after sizing and measurement.

Outcome measures and follow-up

Clinical assessments were performed preoperatively and postoperatively at 1 month, 3 months, 6 months, and 1 year. Clinical outcomes included neck pain measured using a visual analog scale (VAS), functional disability using the Neck Disability Index (NDI), and neurological status using the Japanese Orthopaedic Association (JOA) score (17-point system, 1994 revision).

Adjacent segment disease (ASD) surveillance was performed using lateral cervical radiographs and T2-weighted MRI. Radiographic degeneration was graded using the Kellgren cervical degeneration system on radiographs, and MRI degeneration was graded using the Miyazaki classification. Imaging outcomes were reviewed by an independent spine surgeon and radiologist blinded to treatment details.

Statistical analysis

Data were analyzed using SPSS (version 22). Continuous variables are reported as mean ± standard deviation and were compared between groups using Student's t-test. Categorical variables were compared using the chi-square test. Statistical significance was defined as $p < 0.05$.

Ethics and consent

Written informed consent was obtained from all participants, and the study was conducted in accordance with institutional clinical research and patient confidentiality standards.

RESULTS

Cohort and baseline characteristics

Fifty patients were included (CAD, n=25; Zero-P, n=25). Baseline demographic characteristics and preoperative functional status were similar between groups, with no statistically significant differences in sex distribution, age, BMI, or work status at presentation (**Table 1**).

Table 1. Baseline characteristics

Variable	CAD (n=25)	Zero-P (n=25)	Test statistic	p value
Sex (male/female), n (%)	15 (60) / 10 (40)	12 (48) / 13 (52)	χ^2=0.32	0.57
Age (years), mean ± SD	46.24 ± 7.71	45.24 ± 7.37	t=0.46	0.64
BMI (kg/m²), mean ± SD	27.87 ± 3.45	27.25 ± 2.64	t=0.70	0.48
Work status at presentation: able, n (%)	21 (84)	15 (60)	χ^2=2.4	0.11

Clinical outcomes

Functional outcomes and pain improved over time in both groups. NDI trajectories differed between groups at 3 and 6 months but converged by 1 year (Table 3, Fig. 1). VAS pain scores were significantly lower in the CAD group from 3 months through 1 year (Table 3, Fig. 2). JOA scores did not differ significantly between groups at baseline or 1 year (**Table 3**).

Table 3. Clinical outcomes over time

A. Neck Disability Index (NDI), mean ± SD

Timepoint	CAD (n=25)	Zero-P (n=25)	p value
Baseline	60.92 ± 9.47	57.68 ± 7.97	0.1970
1 month	46.36 ± 7.99	45.68 ± 8.28	0.7690
3 months	23.72 ± 5.42	21.24 ± 2.01	0.0400
6 months	18.76 ± 2.45	16.28 ± 1.95	0.0003
1 year	14.56 ± 0.65	14.28 ± 0.98	0.2406

B. Visual Analog Scale (VAS), mean ± SD

Timepoint	CAD (n=25)	Zero-P (n=25)	p value

Baseline	76.22 ± 7.46	78.6 ± 9.84	0.34
1 month	68.8 ± 8.58	66.76 ± 8.17	0.39
3 months	19.96 ± 1.99	29.62 ± 2.56	< 0.05
6 months	16.38 ± 3.30	24.26 ± 2.76	< 0.05
1 year	15.32 ± 5.60	23.14 ± 2.96	< 0.05

C. Japanese Orthopaedic Association (JOA) score, mean ± SD

Timepoint	**CAD (n=25)**	**Zero-P (n=25)**	**p value**
Baseline	11.36 ± 1.60	12.24 ± 0.97	0.0640
1 year	9.72 ± 1.70	10.04 ± 1.46	0.4778

Figure 1. Mean Neck Disability Index (NDI) scores over time in the cervical artificial disc arthroplasty (CAD) and zero-profile interbody fusion (Zero-P) cohorts. Error bars indicate standard deviation.

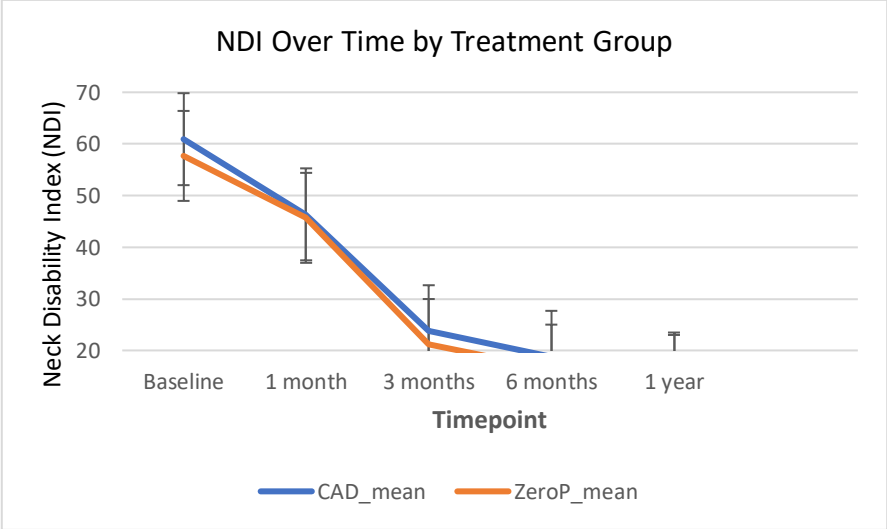
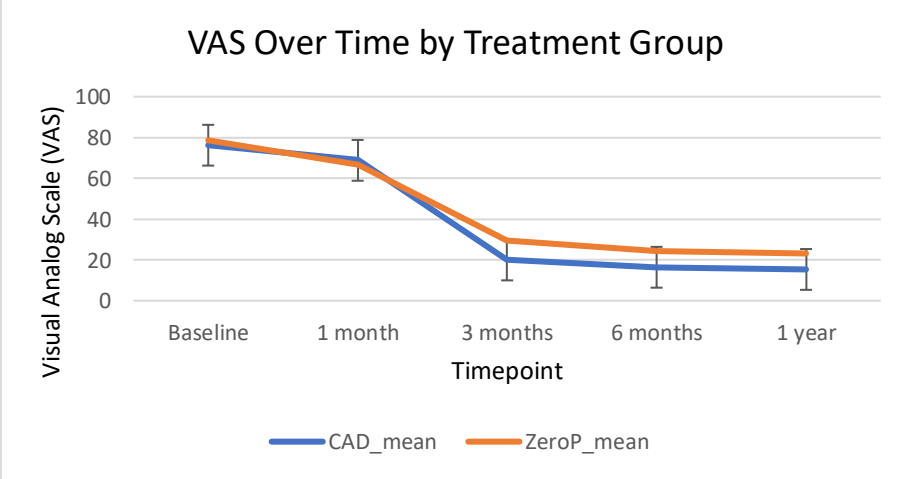


Figure 2. Mean visual analog scale (VAS) scores over time in the cervical artificial disc arthroplasty (CAD) and zero-profile interbody fusion (Zero-P) cohorts. Error bars indicate standard deviation.



Reintervention and adjacent segment disease

Subsequent surgical intervention and ASD were infrequent and did not differ significantly between cohorts (**Table 4**).

Table 4. Subsequent intervention and adjacent segment disease

Outcome	**CAD (n=25) n (%)**	**Zero-P (n=25) n (%)**	**p value**

Subsequent surgical intervention	1 (4)	2 (8)	1.00
Adjacent segment disease (ASD)	1 (4)	3 (12)	0.6022
Outcome	**CAD (n=25) n (%)**	**Zero-P (n=25) n (%)**	**p value**

DISCUSSION

In this prospective comparative study, both cervical disc arthroplasty (CAD) and zero-profile interbody fusion (Zero-P) produced significant improvements in pain and functional outcomes for single-level cervical degenerative disc disease. While long-term functional outcomes were similar between groups, CAD demonstrated a consistent advantage in pain reduction from 3 months onward. Neurological recovery, operative parameters, reoperation rates, and adjacent segment disease (ASD) incidence were comparable.

Pain outcomes and functional recovery

The most robust finding of the present study was the significantly lower VAS pain scores observed in the CAD cohort at 3, 6, and 12 months. At 1 year, mean VAS was 15.32±5.60 following CAD compared with 23.14±2.96 after Zero-P fusion. This finding closely parallels large comparative meta-analyses. Gao et al. analyzed 27 randomized trials and reported significantly lower neck and arm pain scores following cervical arthroplasty compared with ACDF ($p<0.05$), despite longer operative times and greater blood loss in the arthroplasty group [10]. Similarly, McAfee et al. reported superior overall success for arthroplasty (77.6%) compared with ACDF (70.8%), with a pooled odds ratio of 0.699 (95% CI 0.539–0.908; $p=0.007$), driven in part by improved pain and neurological outcomes [7].

Functional disability improved in both cohorts in our study, with NDI scores converging by 1 year. This convergence is consistent with long-term outcome data. Sasso et al., in a randomized controlled trial with 10-year follow-up, demonstrated durable improvements in both arthroplasty and fusion cohorts, although final NDI scores favored arthroplasty (8 vs 16; $p=0.0485$) [8]. However, Quinto et al. reported that although CDA showed statistically superior NDI scores at 10 years, these differences did not meet minimal clinically important difference thresholds, underscoring the clinical equivalence of both procedures for long-term functional recovery [9]. Our findings align with these observations, suggesting that arthroplasty may confer earlier or intermediate benefits, while long-term disability outcomes remain similar.

Neurological outcomes

Neurological improvement, assessed by JOA score, did not differ significantly between groups in the present study. This finding is consistent with long-term comparative evidence. Quinto et al. reported no significant difference in neurological success between CDA and ACDF at 10-year follow-up despite statistically lower JOA scores in the CDA group ($p<0.05$) [9]. McAfee et al. demonstrated higher neurological success with arthroplasty (OR 0.552; 95% CI 0.364–0.835; $p=0.005$), but the absolute differences were modest [7]. Collectively, these data support the concept that neurological recovery is primarily dependent on adequate decompression rather than implant selection, particularly in single-level disease.

Reoperation and adjacent segment disease

Reoperation and ASD rates were numerically lower in the CAD group in our study, although these differences did not reach statistical significance. This is not unexpected given the modest sample size and limited follow-up. Larger meta-analyses consistently demonstrate lower secondary surgery rates following arthroplasty. Zhong et al. reported a significantly lower overall reoperation rate for CDA compared with ACDF (6% vs 12%; RR 0.54; 95% CI 0.36–0.80; $p=0.002$), with fewer reoperations at both index (RR 0.50; $p<0.001$) and adjacent levels (RR 0.52; $p<0.001$) [6]. Similarly, Quinto et al. found significantly fewer secondary surgeries and adverse events after CDA at 10 years ($p<0.05$) [9].

However, the relationship between motion preservation and ASD remains complex. Verma et al., in a meta-analysis of prospective trials, reported no statistically significant difference in ASD rates between ACDF and total disc arthroplasty (6.9% vs 5.1%; $p=0.44$), despite a lower annualized reoperation rate for ASD after arthroplasty (1.1% vs 2.4% per year) [12]. Our findings are consistent with these results and suggest that while arthroplasty may reduce the need for secondary surgery in some patients, ASD development is multifactorial and not entirely prevented by motion preservation alone.

Biomechanical rationale for arthroplasty

The pain advantage observed with CAD may be explained by preservation of near-physiological cervical kinematics. Galbusera et al. demonstrated, using finite element modeling, that cervical disc arthroplasty preserved segmental motion and maintained near-normal facet joint loading, with only minor increases in forces at the implanted level [13]. Large randomized clinical trials further support this biomechanical advantage. Mummaneni et al. reported maintenance of segmental motion averaging more than 7° at 24 months following arthroplasty, along with higher neurological success rates and fewer secondary surgeries compared with ACDF [14].

Nonetheless, arthroplasty has recognized limitations. Fong et al. identified postoperative kyphotic alignment through the Bryan disc prosthesis in 9 of 10 patients, with a mean kyphotic change of −7° and a reduction in functional spine unit height of 1.7 mm (p=0.040), highlighting the importance of implant design and surgical technique [15]. These findings emphasize that motion preservation alone does not guarantee optimal sagittal alignment.

Role of zero-profile fusion devices

Zero-profile interbody fusion devices were developed to address complications associated with anterior plating. Yan and Nie demonstrated lower dysphagia rates with Zero-P devices (16.3% vs 46.9%), shorter operative time, less blood loss, and superior improvements in JOA, VAS, and NDI compared with plated constructs ($p<0.05$) [11]. The favorable outcomes observed in our Zero-P cohort support the role of modern stand-alone fusion systems as effective and less morbid alternatives to traditional plated ACDF, particularly in patients who are not ideal candidates for arthroplasty.

LIMITATIONS

The limitations of this study include its nonrandomized design, relatively small sample size, and limited follow-up duration. Radiographic motion analysis, heterotopic ossification grading, and long-term sagittal alignment data were not available. These factors limit direct comparison with large randomized trials and long-term meta-analyses.

CLINICAL IMPLICATIONS

Both cervical disc arthroplasty and zero-profile interbody fusion are effective surgical options for single-level cervical degenerative disc disease. Arthroplasty may provide superior intermediate-term pain relief and potentially reduce the need for secondary surgery, while functional and neurological outcomes appear comparable. Careful patient selection remains critical, particularly with respect to facet integrity, sagittal alignment, and implant-specific considerations.

CONCLUSION

In this prospective comparative study of single-level cervical degenerative disc disease, both cervical disc arthroplasty and zero-profile interbody fusion resulted in significant improvements in pain, functional status, and neurological outcomes. While functional recovery as measured by the Neck Disability Index was comparable between groups at 1 year, cervical disc arthroplasty demonstrated superior pain relief from 3 months onward. Neurological recovery, operative parameters, reintervention rates, and adjacent segment disease incidence were similar between procedures. These findings suggest that cervical disc arthroplasty may offer an advantage in intermediate-term pain reduction, whereas both procedures provide equivalent functional and neurological outcomes in the short term. Careful patient selection remains essential, and longer-term follow-up is required to determine whether the observed pain benefits of arthroplasty translate into sustained clinical or radiographic advantages.

REFERENCES

1. Zigler, J. E., Delamarter, R., Murrey, D., Spivak, J., & Janssen, M. (2013). ProDisc-C and anterior cervical discectomy and fusion as surgical treatment for single-level cervical symptomatic degenerative disc disease: five-year results of a Food and Drug Administration study.6. Zhong, Z. M., Zhu, S. Y., Zhuang, J. S., Wu, Q., & Chen, J. T. (2016). Reoperation after cervical disc arthroplasty versus anterior cervical discectomy and fusion: a meta-analysis. Clinical Orthopaedics and Related Research®, 474(5), 1307-1316.
2. Zhong, Z. M., Zhu, S. Y., Zhuang, J. S., Wu, Q., & Chen, J. T. (2016). Reoperation after cervical disc arthroplasty versus anterior cervical discectomy and fusion: a meta-analysis. *Clinical Orthopaedics and Related Research®*, *474*(5), 1307-1316.
3. Wu, J. C., Hsieh, P. C., Mummaneni, P. V., & Wang, M. Y. (2015). Spinal motion preservation surgery. *BioMed research international*, *2015*, 372502.
4. Albanese, V., Certo, F., Visocchi, M., &Barbagallo, G. M. (2017). Multilevel anterior cervical diskectomy and fusion with zero-profile devices: analysis of safety and feasibility, with focus on sagittal alignment and impact on clinical outcome: single-institution experience and review of literature. *World Neurosurgery*, *106*, 724-735.
5. Alhashash, M., Shousha, M., & Boehm, H. (2018). Adjacent segment disease after cervical spine fusion: evaluation of a 70 patient long-term follow-up. *Spine*, *43*(9), 605-609.
6. Zhong ZM, Zhu SY, Zhuang JS, Wu Q, Chen JT. Reoperation after cervical disc arthroplasty versus anterior cervical discectomy and fusion: a meta-analysis. *Clin OrthopRelat Res*. 2016;474(5):1307–1316.
7. McAfee PC, Reah C, Gilder K, Eisermann L, Cunningham B. A meta-analysis of comparative outcomes following cervical arthroplasty or anterior cervical fusion: results from 4 prospective multicenter randomized clinical trials and up to 1226 patients. *Spine*. 2012;37(11):943–952.
8. Sasso WR, Smucker JD, Sasso MP, Sasso RC. Long-term clinical outcomes of cervical disc arthroplasty: a prospective, randomized, controlled trial. *Spine*. 2017.
9. Quinto ES Jr, Paisner ND, Huish EG Jr, Senegor M. Ten-year outcomes of cervical disc arthroplasty versus anterior cervical discectomy and fusion: a systematic review with meta-analysis. *Spine*. 2024;49(7):463–469.
10. Gao Y, Liu M, Li T, Huang F, Tang T, Xiang Z. A meta-analysis comparing the results of cervical disc arthroplasty with anterior cervical discectomy and fusion for the treatment of symptomatic cervical disc disease. *J Bone Joint Surg Am*. 2013;95(6):555–561.
11. Yan B, Nie L. Clinical comparison of Zero-profile interbody fusion device and anterior cervical plate interbody fusion in treating cervical spondylosis. *Int J Clin Exp Med*. 2015;8(8):13854–13861.

12. Verma K, Gandhi SD, Maltenfort M, et al. Rate of adjacent segment disease in cervical disc arthroplasty versus single-level fusion: meta-analysis of prospective studies. *Spine*. 2013;38(26):2253–2257.
13. Galbusera F, Bellini CM, Raimondi MT, Fornari M, Assietti R. Cervical spine biomechanics following implantation of a disc prosthesis. *Med Eng Phys*. 2008;30(9):1127–1133.
14. Mummaneni PV, Burkus JK, Haid RW, Traynelis VC, Zdeblick TA. Clinical and radiographic analysis of cervical disc arthroplasty compared with allograft fusion: a randomized controlled clinical trial. *J Neurosurg Spine*. 2007;6(3):198–209.
15. Fong SY, DuPlessis SJ, Casha S, Hurlbert RJ. Design limitations of Bryan disc arthroplasty. *Spine J*. 2006;6(3):233–241.