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Minimally Invasive Posterior Cervical Fusion With Facet Cages to Augment High-Risk Anterior Cervical Arthrodesis: A Case Series

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Abstract

Study Design: Retrospective case series.

Objectives: To evaluate the efficacy and results of minimally invasive posterior cervical fusion with facet cages as an augment to high-risk patients and patients status post multilevel anterior cervical decompression and fusion.

Methods: Thirty-five patients with symptomatic cervical stenosis with high risk for pseudoarthrosis underwent circumferential cervical decompression and fusion via staged anterior and posterior approach. Anterior cervical decompression and fusion was performed first by means of the standard anterior approach, with the patient supine on the operating table. The patients were subsequently flipped into a prone position and minimally invasive posterior cervical facet fusion with DTRAX was performed. The patients were then followed in the outpatient clinic for an average of 312.71 days. Postoperative patient satisfaction scores were obtained via the visual analogue scale (VAS). Preoperative VAS scores were compared with postoperative VAS scores in order to evaluate patient outcomes.

Results: Of the 35 patients evaluated, minimum follow-up was 102 days, with a maximum follow-up of 839 days. Average preoperative and postoperative VAS scores were 7.6 and 2.8, respectively ($P < .0001$), with an average improvement of 4.86 points. This was an average improvement of 64.70% from preoperative to postoperative. Seventeen patients had excellent outcomes, with a postoperative VAS score ≤ 2. Seven patients achieved a postoperative VAS score of 0, with 100% improvement of preoperative pain and symptoms. Average blood loss was 70.38 mL. Average length of stay was 1.03 days.

Conclusions: The results indicate that minimally invasive posterior cervical decompression and fusion with facet cages, when combined with standard anterior cervical decompression and fusion, is an effective means of obtaining circumferential cervical fusion while simultaneously improving patient outcomes.

Keywords

DTRAX, facet cages, posterior cervical fusion, minimally invasive, tissue sparing

Introduction

Anterior cervical spine decompression and fusion is an effective and well-established treatment for cervical stenosis, cervical radiculopathy, and myelopathy refractory to nonoperative treatment.[1] In this procedure, after completing discectomy and associated osteophyte removal, fusion is achieved by allowing arthrodesis to commence through the intervertebral space. However, fusion is not always achieved and can be associated with persistent pain. High-risk patients for this include those with multiple comorbidities including diabetes, osteoporosis, and smoking. Additionally, those undergoing multilevel surgery are at increased risk for pseudoarthrosis.[2]

The purpose of the current study was to evaluate the efficacy of posterior cervical fusion, done through a tissue sparing approach, with regard to clinical outcomes in those at high risk for pseudoarthrosis and subsidence.

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Minimally invasive surgery (MIS) is becoming a prevalent means of achieving the goals of spinal fusion surgery, particularly in high-risk patients who were previously contraindicated for traditional open surgical intervention. Traditional circumferential cervical fusion is carried out through a standard anterior and posterior approach. However, open posterior cervical fusion surgery with lateral mass fixation has been wrought with postoperative complications, particularly in older patients with multiple comorbidities.[3-5] Additionally, pseudoarthrosis rates are increased for those with similar comorbidities.[6] For this reason, minimally invasive posterior cervical fusion with facet cages has become an increasingly popular method of achieving successful circumferential cervical fusion while simultaneously minimizing the risk of both perioperative and postoperative complications, particularly in the high-risk patient population.[7]

In this investigation, we present the results of a single surgeon series of high-risk patients undergoing both anterior and posterior cervical decompression and fusion using a tissue sparing approach.

Methods

A retrospective study was undertaken in a consecutive series of patients, from 2015 to 2018, who underwent anterior and posterior surgical intervention for multiple-level cervical decompression and fusion. Those who required posterior decompression only or those who required significant posterior-based decompression because of posterior based pathologies were excluded from analysis.

This review was deemed exempt from institutional review board (IRB) review under 45CFR46.101 by an independent central IRB (Ethical and Independent Review Services, Corte, Madera, CA; Protocol Number 15 146-01). Central IRB-approved informed consent was not necessary because the study was retrospective with minimal risk to patient safety. Medical chart review was undertaken for clinical complaints, pain assessment for arm and neck through visual analogue scale (VAS) for pain before surgery and on subsequent follow-up visits. VAS is a scale from 0 to 10, where 0 represents the absence of pain and 10 is consistent with the worst pain imaginable.[5]

Patient Selection

A total of 35 patients were identified who underwent circumferential, staged anterior and posterior cervical decompression and fusion surgery performed by a single surgeon. All patients had one or more of the following criteria: (1) 3 or more levels of anterior cervical decompression and fusion, (2) 2 or more levels of arthrodesis with concomitant comorbidities of osteoporosis, tobacco usage, autoimmune arthritis, and (3) 2 or more levels of arthrodesis with history of pseudoarthrosis in past.

Indications for surgery included disabling neck and arm pain, myelopathy, and/or progressive loss of neurological function. All 35 of the patients were refractory to nonoperative treatment including a minimum of 6 weeks of physician-directed exercise program, activity modification, anti-inflammatory medication, prescription pain medication, as well as spinal injections. All 35 patients had concordant physical examination findings consistent with stenosis and/or pseudoarthrosis.

Anterior cervical decompression and fusion was carried out through the standard open approach. This was then followed with minimally invasive posterior cervical fusion with facet cages. Patient satisfaction and pain scores were routinely obtained both preoperatively and postoperatively utilizing the VAS.[7] The patients were followed in the outpatient clinic for an average of 312.71 days postoperative. The results were then quantified utilizing statistical analysis in order to illustrate patient outcomes.

Preoperatively AP and lateral cervical radiographs with flexion and extension views were obtained in order to rule out underlying instability. Additionally cervical magnetic resonance imaging scan was obtained to determine the extent of both central and foraminal stenosis. Last, computed tomography scan was obtained in order to identify the extent of facet hypertrophy, rule out facet autofusion, and evaluate posterior facet osteophyte complexes.

Surgical Technique

After undergoing anterior cervical decompression and fusion in order to decompress the central cord, restore lordosis, as well as to obtain indirect decompression of the foraminal height, patients were placed in the prone position on a Skytron/Maquet table. Wrist restraints were placed at the foot of the table and used to gently traction the patient's arms and further pull the shoulders out of the field of view. Two C-arms were brought into position. One C-arm was placed at the head of the table for AP view and the other for lateral view.

After optimizing the lateral view by using the table tilt and/or wag, the facet joints were superimposed. The AP view was then optimized. Appropriate levels were identified by means of spinal needle navigation using fluoroscopy. This was done prior to making the skin incision. In general, the skin incision was about 2 levels or 2 fingerbreadths inferior to the target level. The spinal needle was advanced toward the midpoint of the facet on the AP view and toward the inferior tip of the facet on the lateral view. The incision was then made along the same trajectory as the spinal needle.

An access chisel was then introduced in line with the muscle fibers in order to create a vertical path through the thoracodorsal fascia. Care was taken to ensure that the access chisel entered into the facet joint in a medial to lateral trajectory, thus avoiding iatrogenic impingement of the neural foramina. Next, the facet capsule was decorticated with a trephine. A guide tube/working cannula was then introduced over the access chisel such that medial clear space was maintained and the anterior margin of superior articular facet was respected, to avoid iatrogenic impingement of the exiting nerve root. The access chisel was then removed, the guide tube was left in place within

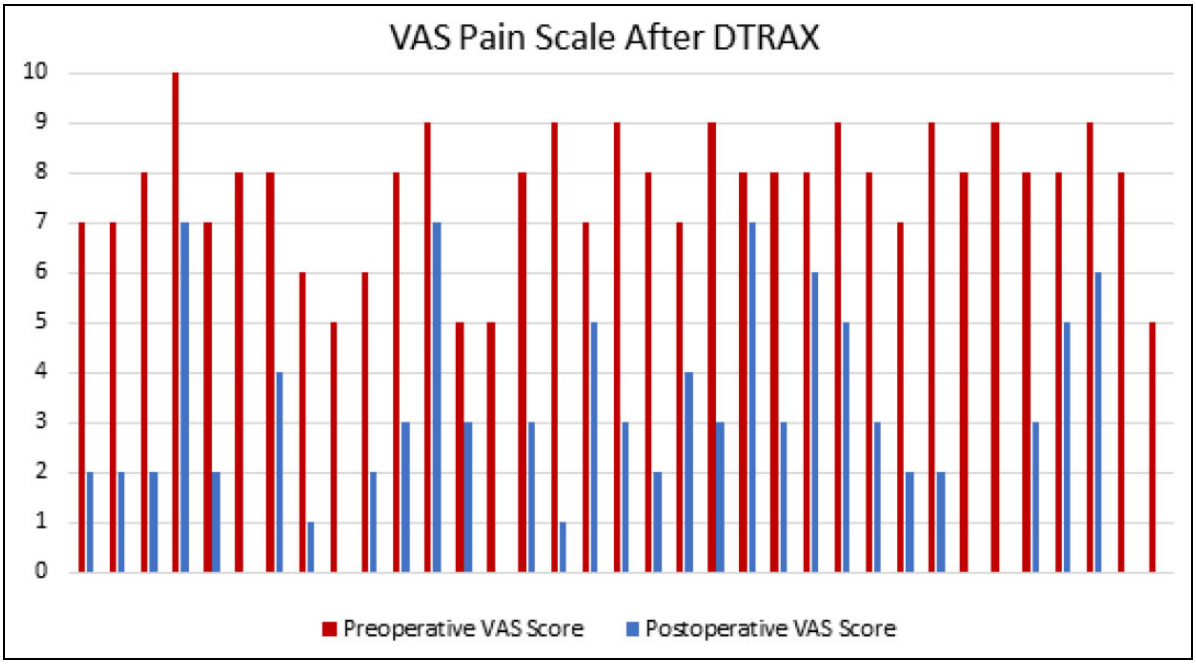

Figure 1. Preoperative and Postoperative VAS pain Pain Scores. Patient recorded VAS pain scores preoperatively and postoperatively demonstrating difference in pain score across all patients with average of 7.6 preoperatively and 2.8 postoperatively ($P < .00001$).

the facet joint, and the facet joint was reamed using a decortication burr or rasp. The implantable facet joint cage was filled with graft material prior to delivery. Graft was obtained from the posterior iliac crest through a separate fascial incision. Allograft bone was also utilized where indicated. After delivering the appropriately sized implant into the facet joint, a bone screw was introduced and locked into the facet cage. Additional bone graft was then delivered through the guide tube and into the facet joint.

Hospital stay was defined from end of surgery to hospital discharge. Estimated blood loss was obtained from anesthesia and operative records. Surgical complications occurring within 30 days of surgery were noted. VAS scores were obtained preoperatively and at each follow-up visit subsequently. Data was compared using the Wilcox rank sum test with $\alpha = .05$ for significance.

Results

Of the 35 patients evaluated, minimum follow-up was 102 days, with a maximum follow-up of 839 days.

The demographics and characteristics of the patients included in this study are as follows. Twenty females and 15 males, all of whom underwent staged anterior and posterior cervical decompression and fusion by a single surgeon from 2015 through 2018. The average age of the patients included was 55.23 years. Age range was 40 years to 81 years. Five patients had follow-up of 162 days or less, with the shortest follow-up being 102 days postoperative. Maximum follow-up was 839 days. Twenty-three of the 35 patients had both the anterior and posterior procedures performed in the same day. The remaining 12 patients underwent staged anterior and posterior surgery, with 1 day in between the 2 procedures. Four of the patients were workman's compensation cases. Sixteen of the 35 patients were active tobacco smokers at the time of surgery and for the entirety of the postoperative period. Three of the 35 patients were diabetic. Twenty-six of the 35 patients underwent 3- to 4-level anterior and posterior cervical fusion surgery. Eight patients underwent 2-level anterior and posterior cervical fusion surgery. The most commonly affected level in this case study was the C5-C6 level, which was instrumented in all 35 patients. This was followed by C4-C5, which was instrumented in 28 patients, and C6-C7, which was instrumented in 26 patients (Figure 1).

Average preoperative and postoperative VAS scores were 7.6 and 2.8, respectively ($P < .00\,001$), with average improvement of 4.86 points, or 64.70%. Seventeen patients had excellent outcomes, with a postoperative VAS score ≤ 2. Seven patients achieved a postoperative VAS score of 0, with 100% improvement of preoperative pain and symptoms. One patient experienced a VAS delta of 1, with an improvement of just 12.5% (Figure 2).

Estimated blood loss was an average of 70.38 mL, including both the anterior and posterior procedures. The estimated blood loss range for combined anterior and posterior surgery was 30 mL to 320 mL. Length of stay was an average of 1.03 days following posterior stabilization, with the range from 1 to 5 days.

Complications included 2 superficial wound infections secondary to retained suture in the posterior wound. These were treated with a short course of oral antibiotics and resolved. There were no reoperations or readmissions in this series. There were no neurological or vascular complications.

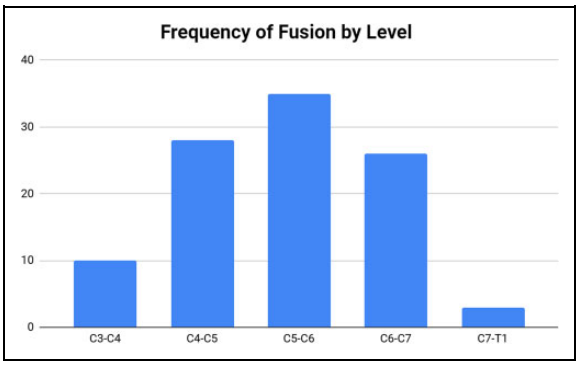

Figure 2. Cervical spinal levels operated upon. Figure demonstrates frequency of levels operated upon with greatest number of levels at c5-6, but spanning from c2-3 to c7-t1.

Specifically, there was no incidence of vertebral artery injury, spinal cord injury, or nerve root palsy observed.

Discussion

DTRAX posterior cervical facet cages provide a minimally invasive, tissue sparing approach to performing posterior cervical fusion surgery without significantly disrupting cervical paraspinal musculature or significantly affecting the posterior tension band. Traditional open posterior cervical fusion surgery with lateral mass fixation has been wrought with postoperative complications, particularly in elderly patients with multiple comorbidities.[3] One study analyzing 3401 patients that underwent traditional open posterior cervical fusion surgery with LMS fixation exhibited a 30-day readmission rate of 6.20%.[1] A total of 4.97% of the patients required a return to the operating room.[8] Postoperative infection was the most common complication at 17.06%.[1] DTRAX provides an alternative posterior approach for a select patient population.

This innovative, tissue sparing, minimally invasive posterior cervical approach allows for faster recovery time, shorter hospital stay, and negligible blood loss.[9] Furthermore, a 2013 study by McCormack evaluating 60 patients who underwent DTRAX surgery illustrated zero vertebral artery injuries, nerve root injuries, spinal cord injuries, or reoperations.[9] Additionally, research has demonstrated that minimally invasive posterior cervical fusion with facet cages yields similar stability to traditional open posterior cervical fusion surgery with lateral mass screws.[10,11]

By using a tissue sparing approach, with posterior cervical cages being placed bilateral into the facets, less tissue dissection is undertaken and the posterior tension band of the neck is less disrupted. Additional areas of fusion are created and additional points of fixation are introduced. Thus, the musculature is less disrupted and the instantaneous stability is augmented as compared to stand-alone anterior cervical decompression and fusion.[9]

While patients undergoing anterior cervical decompression and fusion have good to excellent outcomes, as is demonstrated in multiple meta-analysis along with large case series,[1,2] there is a subset of high-risk patients that demonstrate inferior results.[2,12] Increased complications, and particularly pseudoarthrosis complications resulting in persistent pain and/or radiculopathy and subsidence, have been noted with increasing number of levels operated, comorbidities of smoking, diabetes, and autoimmune disorders. Posterior cervical fusion surgery is used to treat symptomatic pseudoarthrosis but this posterior treatment has its own functional limitations as discussed above.

This is the first case series in the literature that examines high-risk patients with anterior cervical decompression and fusion augmented by tissue sparing posterior cervical decompression and fusion. The results from our series indicate that augmenting multiple-level anterior cervical decompression and fusion surgery with posterior cervical fusion, performed through a minimally invasive approach with posterior cervical facet cages, allows for clinical improvement and arthrodesis to be achieved in a reliable manner with minimal immediate postoperative complications. Additionally, our results demonstrate that VAS scores show that a minimal clinically important difference (MCID) in a reliable pattern in a high percentage of patients that undergo such surgical intervention.[13] Our results reached statistical significance with $P < .000$, with a difference in VAS score of 46.8 mm, which is greater than the reduction of 30 mm which is accepted as the MCID for VAS.[13]

This study has limitations. It is a retrospective review and is thus limited by the study limitations therein. Additionally, this study does not have greater than 2-year follow-up, which will be necessary in order to understand long-term effects on adjacent levels as compared to anterior only arthrodesis. Further analysis is required in order to assess long-term fusion data as well as alignment data with regard to multiple-level arthrodesis.

Conclusions

The results indicate that minimally invasive posterior cervical decompression and fusion with facet cages, when combined with standard anterior cervical decompression and fusion, is an effective means of obtaining circumferential cervical fusion while simultaneously improving patient outcomes in high risk patients.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Rahul V. Shah, MD, is a paid consultant for Providence Medical Technologies for Teaching.

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References

1. Emery SE, Bohlman HH, Bolesta MJ, Jones PK. Anterior cervical decompression and arthrodesis for the treatment of cervical spondylotic myelopathy. Two to seventeen-year follow-up. *J Bone Joint Surg Am*. 1998;80:941-951.
2. Fraser JF, Hartl R. Anterior approaches to fusion of the cervical spine: a meta-analysis of fusion rates. *J Neurosurg Spine*. 2007;6: 298-303.
3. Albarawi MM, Audat ZA, Obeidat MM, et al. Decompressive cervical laminectomy and lateral mass screw-rod arthrodesis. Surgical analysis and outcome. *Scoliosis*. 2011;6:10.
4. Pateder DB, Carbone JJ. Lateral mass screw fixation for cervical spine trauma: associated complications and efficacy in maintaining alignment. *Spine J*. 2006;6:40-43.
5. Siemionow KB, Glowka P, Blok RJ, et al. Perioperative complications in patients treated with posterior cervical fusion and bilateral cages. *J Craniovertebr Junction Spine*. 2017;8:342-349. doi:10.4103/jcvjs.jcvjs_61_17
6. Guo Q, Bi X, Ni B, et al. Outcomes of three level anterior decompression and fusion techniques in the treatment of three level cervical spondylosis. *Eur Spine J*. 2011;20:1539-1544.
7. Mantha S, Thised R, Foss J, Ellis JE, Roizen MF. A proposal to use confidence interval for Visual Analog Scale data for pain measurement to determine clinical significance. *Anesth Analg*. 1993;77:1041-1047.
8. Choy W, Lam SK, Smith ZA, Dahdaleh NS. Predictors of 30-day hospital readmission after posterior cervical fusion in 3401 patients. *Spine (Phila Pa 1976)*. 2018;43:356-363. doi:10.1097/brs.0000000000001450
9. McCormack BM, Bundoc RC, Ver MR, Ignacio JMF, Berven SH, Eyster EF. Percutaneous posterior cervical fusion with the DTRAX Facet System for single-level radiculopathy: results in 60 patients. *J Neurosurg Spine*. 2013;18:245-254. doi:10.3171/2012.12.spine12477
10. Voronov LI, Siemionow KB, Havey RM, Carandang G, Patwardhan AG. Biomechanical evaluation of DTRAX® posterior cervical cage stabilization with and without lateral mass fixation. *Med Devices (Auckl)*. 2016;9:285-290. doi:10.2147/mder.s111031
11. Voronov LI, Siemionow KB, Havey RM, Carandang G, Phillips FM, Patwardhan AG. Bilateral posterior cervical cages provide biomechanical stability: assessment of stand-alone and supplemental fixation for anterior cervical discectomy and fusion. *Med Devices (Auckl)*. 2016;9:223-230.
12. Shriver MF, Lewis DJ, Kshettry VR, Rosenbaum BP, Benzel EC, Mroz TE. Pseudoarthrosis rates in anterior cervical discectomy and fusion: a meta-analysis. *Spine J*. 2015;15:2016-2027.
13. Lee JS, Hobden E, Stiell IG, Wells GA. Clinically important change in the Visual Analog Scale after adequate pain control. *Acad Emerg Med*. 2003;10:1128-1130.