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Original Article

Safety and efficacy of lateral mass screws at C7 in the treatment of cervical degenerative disease

Chengmin Zhang[1,2], Qiang Zhou[2], Paul M. Arnold[1]

[1]Department of Neurosurgery, University of Kansas Medical Center, Kansas City, Kansas, USA, [2]Department of Orthopedics, Southwest Hospital, Third Military Medical University, Chongqing, China

E-mail: Chengmin Zhang - czhang7@kumc.edu; Qiang Zhou - zq_tlh@163.com; *Paul M. Arnold - parnold@kumc.edu
*Corresponding author

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Abstract

Background: To evaluate the safety and efficacy of lateral mass screws at C7 in the treatment of cervical degenerative disease.

Methods: Patients with cervical degenerative disease who underwent posterior cervical fusion and fixation from 2009 to 2015 were included in the study. All complications were captured. Postoperative X-ray and computed tomography (CT) confirmed fusion at 6 and 12 months after surgery. X-ray and CT confirmed screw loosening, misplacement, pull-out, breakage, or rod breakage.

Results: Seventy-two patients underwent cervical laminectomy and fixation with lateral mass screws at C7 and had at least 1 year follow-up. One patient had C3 screw pull-out; revision was not required. There were no complications related to the C7 screws, and all were in the lateral mass.

Conclusions: Lateral mass screws are as safe and effective as pedicle screws at C7 in long-segment posterior cervical fixation, have a lower rate of perioperative complications than pedicle screws, and are technically easier to place.

Key Words: Cervical spine, lateral mass screw, pedicle screw, posterior fusion, spinal degenerative disease

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INTRODUCTION

Posterior cervical procedures are performed for degenerative diseases such as cervical myelopathy, ossification of the posterior longitudinal ligament (OPLL), and multilevel disc herniation. Decompression relieves pressure on the spinal cord and fixation helps maintain cervical alignment and stability. There are several techniques for screw placement in the subaxial cervical spine. Lateral mass screws (LMS) and pedicle screws (PS) are the most commonly used.[7] Lateral mass screws are more commonly used as they are less technically demanding. However, placement of lateral mass screws at C7 can be challenging. C7 anatomy is different from other cervical vertebrae as it transitions to the thoracic spine.[2] Further, because C7 is often the most caudal point of fixation in multilevel constructs and is the site of highest stress concentration, optimal screw placement concerns are often focused on C7. In several biomechanical studies, PS have been shown

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to have superior pull-out strength in comparison with LMS at C7.[3-5] In several prior studies, authors concluded that LMS were as effective as PS at C7 in biomechanically stabilizing subaxial cervical fixation.[12] Notably, the rates of vertebral artery injury and nerve root injury are significantly higher in PS than LMS, but the rate of screw loosening is lower in PS than LMS.[13] The purpose of this study was to evaluate the safety and efficacy of LMS at C7.

MATERIALS AND METHODS

This was a retrospective study of 72 patients who were followed for 1 year following posterior cervical fusion from January 2009 to August 2015 addressing cervical degenerative disease.

Inclusion/Exclusion criteria

The details of inclusion and exclusion criteria are listed in Table 1.

Clinical outcomes and radiographic assessment

Patients' clinical outcomes [using visual analog scale (VAS)] and radiographic outcomes [computed tomography (CT), dynamic X-rays] were assessed preoperatively and postoperatively 6 months and 1 year.

Surgery technique

Lateral mass screws were placed bilaterally from C2-C7. They were placed free hand using anatomic landmarks to locate the entry point; intraoperative X-rays were then used to confirm that all screws were placed correctly.

Table 1: The inclusion and exclusion criteria

Inclusion Criteria
Clinical/Radiographic evidence of cervical degenerative disease (cervical myelopathy, multilevel cervical disc herniation, OPLL, etc.)
Underwent posterior cervical decompression and fixation that stopped at C7
At least had a minimum 1-year follow-up
Exclusion Criteria
Trauma, tumor, or infection
Underwent posterior cervical decompression and fixation that stopped at C3-C6 or extended to T1-T3

Following cervical laminectomies (average 3.5 levels), rods were cut to size and placed bilaterally within the screw heads. Bone from the laminectomy was then used for the fusion [Figures 1-3].

RESULTS

All 72 patients had at least 1 year follow-up. There were 32 females and 40 males; mean age was 63.7 years. Of the 72 patients, 29 had cervical stenosis, 39 had cervical myelopathy, 3 had post-laminectomy kyphosis, and 1 had cervical central cord syndrome. Levels operated were C3–C7 (46 patients), C4–C7 (17), C5–C7 (8), and C2–C7 (1). Follow-up ranged from 12 to 72 months.

Outcomes

Clinical outcomes in all 83 patients were good and all patients reported relief of neck and radiating pain [Table 2 and Figure 4]. No new neurologic dysfunction was found, and there was no evidence of screw malplacement.

Complications

The complication rate was low. There were no neurovascular, spinal central cord, or nerve root injuries in all 72 patients. A cerebrospinal fluid (CSF) leak was reported in 1 patient intraoperatively and the dura was repaired primarily. Screw loosening was confirmed by X-ray and CT at the C3 level in 1 patient during the postoperative period; the patient did not require further surgery. There were no screw-related complications and there were no revision surgeries. Specifically, there was no evidence of neural injury, vascular injury, screw breakage, or screw pull-out related to insertion at the C7 level.

DISCUSSION

Posterior cervical fixation is the standard treatment for this disease. LMS are commonly used in posterior cervical fixation, with good clinical outcomes and low rates of complications. Most surgeons use LMS from C3–C6, but controversy remains regarding the use of LMS and PS at C7. LMS have good clinical outcomes, a low rate of complications, a high rate of fusion, and a low rate of screw loosening and breakage.[1]

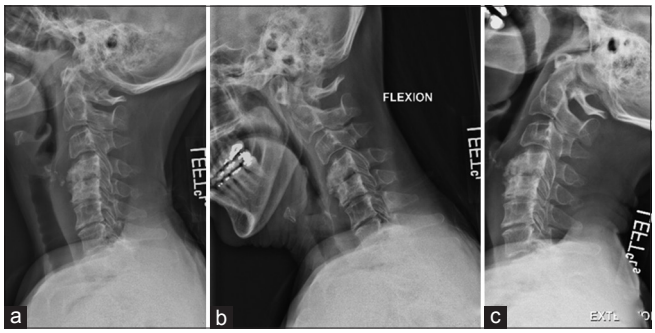

Figure 1: A 57-year-old female with cervical myelopathy; preoperative lateral X-rays: (a) neutral; (b) flexion; (c) extension

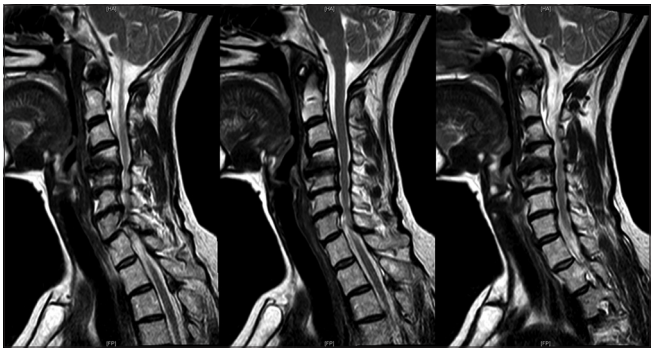

Figure 2: Same patient; preoperative sagittal MRI

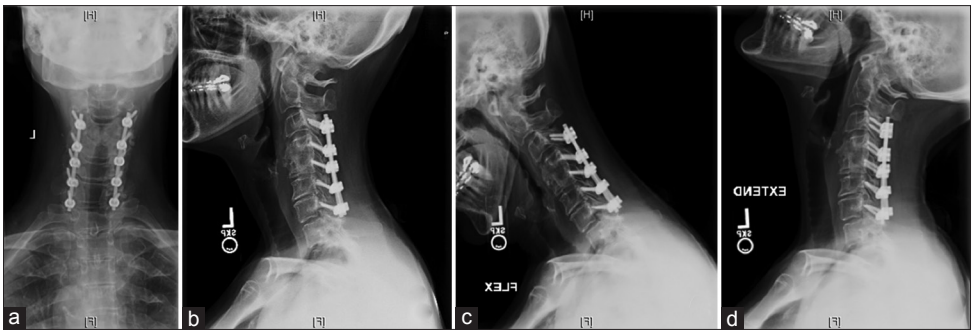

Figure 3: Same patient; postoperative X-rays: Image (a) AP; (b) neutral; (c) flexion; and (d) extension

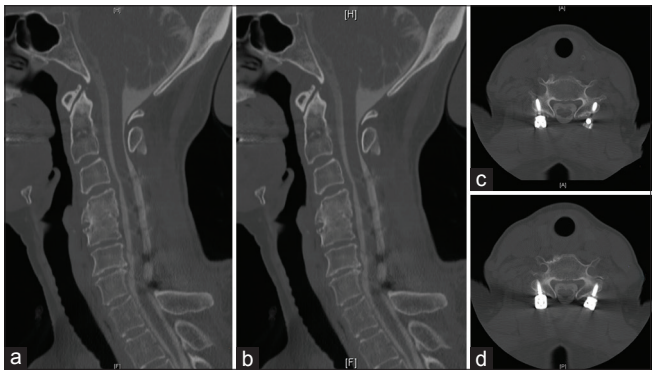

Figure 4: Same patient; (a and b) CT myelogram; (c and d) postoperative axial view of C7

Anatomy of the C7 vertebra

The width of the cervical pedicles decreases significantly from C2 to C7 and the unique anatomy of C7, along with the vertebral artery and nerves around the pedicle, result in technical challenges placing PS at C7. Moreover, the pedicle diameter of C7 is small, so there is a higher risk of nerve and vertebral artery injury during placement of PS at C7. Notably, neurovascular injury is the primary complication with the use of PS, whereas the rate of neurovascular injury is lower with the use of LMS at this level. In addition, if LMS are used at C3–C6 and PS at C7, contouring the rod can be difficult.

Yoshihara *et al.*[13] reviewed nine clinical studies regarding the complications of PS in the subaxial cervical spine [Table 3]. The rate of nerve root injury was 0.31% per screw (four cases), vertebral artery injury was 0.15% per screw (three cases), and malposition requiring revision or removal was 0.29% per screw (three cases). Two other studies noted that vertebral artery penetration or injury causing bleeding or occlusion may result in cerebral infarction, dissection, pseudoaneurysm, or death.[6,14] Intraoperative vertebral artery injury at C7 cannot be directly repaired and treatment may require embolization.

Neuronavigation impacts placement of C7 PS

With the development of intraoperative navigation, the accuracy of cervical PS insertion has improved.[10,11] However, complications can still occur, such as C5 nerve root palsy.[9] Not all hospitals have intraoperative navigation imaging and/or computer navigation, and sometimes the patients' shoulders can impede intraoperative fluoroscopy, increasing the risk of neurovascular injury.

Table 2: Clinical VAS outcomes

	Preoperative	Postoperative 6 months	Postoperative 1 year
VAS	5.34±1.15*	2.25±1.24¶	2.07±1.16¶

P was calculated with independent sample *t*-test. * and ¶ denote significant difference

Table 3: The complications rate between LMS and PS

	LMS	PS
Nerve root injury	0.19(10/5130)	0.31(8/2598)
Vertebral artery injury	0(0/5328)	0.15(4/2668)
Malposition	0.38(12/3144)	0.29(5/1711)

No LMS loosening or pull-out

Most surgeons prefer hybrid screw fixation, using LMS from C3–C6 and PS at C7. Some biomechanical studies[3] have shown that PS have superior pull-out strength at C7. Recently, two biomechanical studies showed that LMS could provide the same fixation as PS at C7.[8,12] Our study showed that none of the LMS loosened or pulled out at C7. Two recent biomechanical studies support LMS for fixation of C7. One study compared the immediate and post-cyclical rigidities of C7 LMS to C7 PS in posterior C4-7 fixation. In several prior studies, authors concluded that LMS were as effective as PS at C7 in biomechanically stabilizing subaxial cervical fixation.[12] Another study compared C3–C7 LMS to a hybrid construct consisting of C3–C5 LMS and C7 PS in posterior cervical fixation. Results showed that both PS and LMS were similar in restoring stability in posterior cervical fixation.[8]

Late complications of LMS vs. PS

A review regarding late complications of LMS and PS showed no screw loosening,[13] however, some studies[4] showed LMS pull-out in the past 10 years. Both cases that reported LMS pull-out reported that the pull-out level was not C7 but C3–C4; however, some patients had osteoporosis which can decrease the strength of screw purchase.[4] These results are consistent with our results.

In our study, screw pull-out was reported in 1 patient for a rate of 1.3%. There were no complications related to the pull-out of C7 screws.

CONCLUSION

Lateral mass screws are as safe and effective as pedicle screws at C7 in long-segment posterior cervical fixation. In addition, lateral mass screws have a lower rate of perioperative complications than pedicle screws and are technically easier to place.

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Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Coe JD, Vaccaro AR, Dailey AT, Skolasky RL Jr, Sasso RC, Ludwig SC, *et al*. Lateral mass screw fixation in the cervical spine: A systematic literature review. J Bone Joint Surg Am 2013;95:2136-43.
2. Desai S, Sethi A, Ninh CC, Bartol S, Vaidya R. Pedicle screw fixation of the C7 vertebra using an anteroposterior fluoroscopic imaging technique. Eur Spine J 2010;19:1953-9.
3. Johnston TL, Karaikovic EE, Lautenschlager EP, Marcu D. Cervical pedicle screws vs. lateral mass screws: Uniplanar fatigue analysis and residual pullout strengths. Spine J 2006;6:667-72.
4. Katonis P, Papadakis SA, Galanakos S, Paskou D, Bano A, Sapkas G, *et al*. Lateral mass screw complications: Analysis of 1662 screws. J Spinal Disord Tech 2011;24:415-20.
5. Mohamed E, Ihab Z, Moaz A, Ayman N, Haitham AE. Lateral mass fixation in subaxial cervical spine: Anatomic review. Global Spine J 2012;2:39-46.
6. Nakashima H, Yukawa Y, Imagama S, Kanemura T, Kamiya M, Yanase M, *et al*. Complications of cervical pedicle screw fixation for nontraumatic lesions: A multicenter study of 84 patients. J Neurosurg Spine 2012;16:238-47.
7. Pelton MA, Schwartz J, Singh K. Subaxial cervical and cervicothoracic fixation techniques--indications, techniques, and outcomes. Orthop Clin North Am 2012;43:19-28, vii.
8. Regan CM, Emmanuel S, Hornik C, Weinhold P, Lim MR. Lateral mass versus hybrid construct for cervical laminectomy and fusion. Orthopedics 2013;36:e484-8.
9. Theologis AA, Burch S. Safety and Efficacy of Reconstruction of Complex Cervical Spine Pathology Using Pedicle Screws Inserted with Stealth Navigation and 3D Image-Guided (O-Arm) Technology. Spine (Phila Pa 1976) 2015;40:1397-406.
10. Uehara M, Takahashi J, Ikegami S, Mukaiyama K, Kuraishi S, Shimizu M, *et al*. Screw perforation features in 129 consecutive patients performed computer-guided cervical pedicle screw insertion. Eur Spine J 2014;23:2189-95.
11. Uehara M, Takahashi J, Mukaiyama K, Kuraishi S, Shimizu M, Ikegami S, *et al*. Mid-term results of computer-assisted cervical pedicle screw fixation. Asian Spine J 2014;8:759-67.
12. Xu R, McGirt MJ, Sutter EG, Sciubba DM, Wolinsky JP, Witham TF, *et al*. Biomechanical comparison between C-7 lateral mass and pedicle screws in subaxial cervical constructs. Presented at the 2009 Joint Spine Meeting. Laboratory investigation. J Neurosurg Spine 2010;13:688-94.
13. Yoshihara H, Passias PG, Errico TJ. Screw-related complications in the subaxial cervical spine with the use of lateral mass versus cervical pedicle screws: A systematic review. J Neurosurg Spine 2013;19:614-23.
14. Yukawa Y, Kato F, Ito K, Horie Y, Hida T, Nakashima H, *et al*. Placement and complications of cervical pedicle screws in 144 cervical trauma patients using pedicle axis view techniques by fluoroscope. Eur Spine J 2009;18:1293-9.