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Technical Report

Perforations and angulations of 324 cervical medial cortical pedicle screws: a possible guide to avoid lateral perforations with use of pedicle screws in lower cervical spine

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Abstract

BACKGROUND CONTEXT: More than half of the perforations reported with usage of cervical pedicle screws (CPS) are lateral perforations, endangering the vertebral artery. The medial cortical pedicle screw (MCPS) technique with partial drilling of the medial cortex shifts the trajectory of pedicle screws medially, decreasing the lateral perforations.

PURPOSE: To evaluate the decrease in lateral perforations of CPS with use of MCPS technique, in relation to medial angulation.

STUDY DESIGN/SETTING: Retrospective analysis and technical report of the MCPS technique and its safety.

PATIENT SAMPLE: A total of 58 patients operated on between December 2011 and May 2015 with insertion of pedicle screws from C3 to C7 were included in the study.

OUTCOME MEASURES: Axial reconstructed computed tomography (CT) scan images of the inserted screws were evaluated for placement, perforations, and transverse plane angulations using the Surgimap software (Surgimap Spine 1.1.2.271 Intl. 2009 Nemaris LLC). The angulations of screws were analyzed by the type and level of placement through unpaired *t* test and analysis of variance test.

METHODS: A total of 58 patients operated on between December 2011 and May 2015 with insertion of pedicle screws from C3 to C7 were included in the study. There were 49 males and 9 females. Thirty-seven patients had cervical trauma, 17 had cervical spondylotic myelopathy, two had tumors, and two had ankylosing spondylitis. The average age was 49 years (range 18 to 80 years). The screws were inserted using the MCPS technique. All patients underwent postoperative CT scans with GE Optima CT540 16 slice CT scanner (GE Healthcare Chalfont St. Giles, Buckinghamshire, UK). Axial reconstructed images along the axis of the inserted screws were evaluated for placement and perforations. Further, all the screws were evaluated for transverse plane angulations using the Surgimap software. The angulations of screw were analyzed by the type and level of placement through unpaired *t* test and analysis of variance test. No funds were received by any of the authors for the purpose of the present study.

RESULTS: A total of 324 screws were assessed with postoperative CT scans. Two hundred fifty-six were found to be placed within the pedicle and 68 (20.98%) screws were found to have perforations. Forty screws (12.34%) had grade I medial perforations, 14 screws (4.32%) had grade I lateral perforations, 10 screws (3.08%) had grade II medial perforations, and 4 screws (1.23%) had grade II

FDA device/drug status: Not approved for this indication (pedicle screws in the lower cervical spine).

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lateral perforations. The average angulation of the nonperforated screws (n=256) was 28.6° (43°–17°), that of laterally perforated screws was 20.33° (13°–24°), and that of the medially perforated screws was 34.94° (45°–20°). On statistical analysis with each series, the 99% CI range for the in-screw angles was 27.91° to 29.34°; for the laterally perforated screw series, it was 18.42° to 22.23°; and that for the medially perforated screw series was 32.97° to 36.9°.

CONCLUSIONS: The MCPS technique represents a shift in the concept of placement of CPS from the cancellous core to the medial cortex, avoiding screw deflection laterally by the thick proximal medial cortex. The present study shows that the lateral perforations can be consistently avoided, with a medial angulation of more than 27.91°, which is the primary concern with the use of pedicle screws in lower cervical spine. Further, the MCPS technique reduces the lateral perforations at a lesser insertion angle, which is technically desirable.

Keywords: Cervical pedicle screws; Lateral perforations; Medial cortex; Medial cortical pedicle screws; Partial drilling; Transverse angulations

Introduction

Despite two decades since the description of clinical usage of cervical pedicle screws (CPS) by Abumi et al. [1], CPS is not used routinely in clinical practice due to the feared complications. More than half of the perforations reported are lateral perforations, endangering the vertebral artery [2–4]. The architecture of cervical pedicle, having thicker medial wall [5], increases the chances of the screw perforating the lateral pedicle wall. There has been ongoing effort with cadaveric and clinical studies to improvise the technique of CPS insertion in the lower cervical spine to decrease the lateral perforations. Many studies have proposed to increase the transverse angulation of the screw trajectory [6,7], from a more lateral entry, to decrease deflection of the screw laterally by the proximal medial cortex. However, there is a technical difficulty in angulating the screws more than 40 degrees due to paraspinal musculature. A separate paraspinal stab incision needs to be done for each screw [8], which is cumbersome. Therefore, a technique that decreases the lateral perforations consistently, at a lower angulation trajectory, would be more desirable. The medial cortical pedicle screw technique (MCPS) with partial drilling of the medial cortex, shifts the trajectory of pedicle screw along the medial cortex and has already been shown to decrease lateral perforations [9]. The present study evaluates the proposed decrease in lateral perforations at a lower medial angulation with the use of the MCPS technique.

Methods

Our records revealed a total of 67 patients who underwent surgery with placement of lower CPS (C3–C7) between December 2011 and May 2015. The study aimed at including all patients operated on during the above period who underwent cervical surgery with pedicle screw insertion with the MCPS technique. Among the 67 surgeries, only 58 patients could be included in the present study. Seven of the surgeries were performed outside the institute and the MCPS technique was not used in these cases due to lack of appropriate high-speed burr system. Two patients who underwent surgery at the institute with the MCPS technique of screw insertion, succumbed, due to respiratory failure within 2–3 days postoperatively and no postoperative imaging was performed on these two patients. Both these patients had quadriplegia with traumatic cervical subluxation and were operated on with stabilization, after appropriate counseling, for the purpose of better rehabilitation. The rest of the 58 patients operated on between December 2011 and May 2015 with insertion of pedicle screws with the MCPS technique were included in the study. There were 49 males and 9 females. Thirty-seven patients had cervical fracture with trauma, 17 patients had cervical spondylotic myelopathy, two patients had intradural dumb-bell tumors with facet erosion, and two patients had traumatic fracture superimposed on ankylosing spondylitis. The average age was 49 years (range 18 to 80 years). The screws were inserted using the MCPS technique, described earlier [9].

All patients gave appropriate written informed consent for the surgery. The institutional review board did not have any objection for the present study.

Surgical technique

All the screw insertions were performed by either of the first two authors. After posterior exposure, the landmark for insertion of the MCPS was identified—at the center of lateral mass medio-laterally and along a horizontal line just below the articular margin. A 3 mm cutting burr was used to decorticate the area and a 2 mm diamond tip burr was used to partially drill the medial pedicle cortex and enter the vertebral body (Fig. 1). The burr was directed 30°–35° medially and the cranio-caudal direction was decided by lateral fluoroscopy. The pilot hole integrity was confirmed with ball tipped probe and 3.5 mm polyaxial screws were inserted after tapping the initial entry zone. (please refer to video of the technique illustrating partial medial cortical drilling: MCPS technique video—the original audio is retained to enable the viewer to appreciate the drilling technique).

All patients underwent postoperative computed tomography (CT) scans with GE Optima CT540 16 slice CT scanner (GE Healthcare Chalfont St. Giles, Buckinghamshire, UK).