Accuracy of Cervical Pedicle Screw Placement Using the Funnel Technique

Eldin E. Karaikovic, MD, PhD,* Wicharn Yingsakmongkol, MD,† and Robert W. Gaines, Jr., MD†

Study Design. This was a cadaver study assessing the accuracy of cervical pedicle screw placement.

Objective. To evaluate the accuracy of the funnel technique of screw placement.

Summary of Background Data. Although excellent results have been reported in clinical studies, with no major neurovascular injuries, several cadaveric studies have shown a high pedicle perforation rate during screw placement.

Methods. Ten fresh frozen cervical spines (C2–C7) were used (120 pedicles, 20 pedicles per level). The average specimen age was 79.6 years (range 65–97); the average height was 169 cm (range 155–175). The male-to-female ratio was 3:7. Pedicle width and angulation were measured on preoperative axial computed tomography (1-mm slices). By use of four bony landmarks and the funnel technique, screws were placed under direct vision. Critical perforations (documented contact of a screw with, or an injury to, a spinal cord, nerve root, or vertebral artery) and noncritical perforations (a perforation with no critical contact) were recorded.

Results. In seven pedicles (5.8%) the procedure was aborted because of a small or nonexistent pedicle medullary canal. Ninety-four pedicle screws (83.2%) were placed correctly, whereas 11 pedicles (9.3%) had noncritical perforations and 8 pedicles (7.1%) had critical perforations. The majority of the critical and noncritical perforations were at C3, C4, and C5.

Conclusions. Axial computed tomography is necessary for the preoperative planning. Because of the small diameter and steep angulation of cervical pedicles, every spine surgeon who intends to use pedicle screws should first master the technique on cadavers. [Key words: cervical pedicles, perforation, complication, funnel technique] Spine 2001;26:2456–2462

Excellent clinical results have been reported using cervical pedicle screws. A wide spectrum of degenerative, traumatic, inflammatory, and neoplastic diseases have been successfully treated.1–4,7,12

By contrast, several cadaver studies have shown a high perforation rate when cervical pedicle screws were used. The perforation rate, including critical and noncritical perforations, has ranged from 25% to 87.5%.17,19–21 Several methods, some of them very expensive computerized systems guided by computed tomography (CT), were unsuccessfully used in cervical pedicle screw placement. A recent study showed an 18% critical perforation rate when the StealthStation (Sofamor-Danek, Memphis, TN) was used.20 The most successful technique of cervical pedicle screw placement has not been identified. The objective of this study was to evaluate the accuracy of the funnel technique of cervical pedicle screw placement.

Materials and Methods

Ten fresh frozen cervical spines (C2–C7) were used (120 pedicles, 20 pedicles per level). The average specimen age was 79.6 years (range 65–97); the average height was 169 cm (range 155–175). The male-to-female ratio was 3:7. None of the individuals had evidence of infectious or neoplastic diseases or of congenital or developmental spinal malformations. All specimens had various degrees of osteoporosis and degenerative changes expected for age.

Preoperative axial CT (bone windows with 1-mm slices) was performed with the central beam placed parallel to the pedicle axis (Figure 1). The outer width at the pedicle isthmus (a mediolateral diameter between pedicle cortices) and the angle of the medial inclination of the pedicle axis in the horizontal plane were measured for every pedicle. The pedicle axis angle was the angle between the line perpendicular to the posterior cortex of the vertebral body and the line through the pedicle axis.

Surgical Technique. The cadavers were placed prone, with the neck in a neutral position. The posterior approach was used, and a midline incision was made from the external occipital protuberance to the spinous process of the T1 vertebra. All soft tissues of the posterior aspect of the cervical spine were dissected and retracted laterally.

The posterior projection of the pedicle axis (the pedicle entrance) was localized by use of four bony pedicle landmarks (Figure 2): the lateral vertebral notch and the inferior edge of the inferior articular process for all vertebrae (C2–C7), the medial pedicle cortex (for C2 only), and the midline of the base of the transverse process (for C7 only).16

The lateral vertebral notch and lateral edge of the facet joints from C2–C3 to C7–T1 were exposed (Figure 2). Through partial medial retraction of the atlantoaxial membrane, the medial pedicle cortex of C2 was exposed only at C2. The transverse processes were exposed only at C7.

The authors consider every pedicle to be built as a funnel with a wide posterior base, which narrows towards the isthmus. A distinct characteristic of the cervical pedicles is that the lateral pedicle wall is always the thinnest cortex.15,24 Therefore, the medial pedicle cortex was used as a safe guide into the pedicle isthmus, then through it and then into the vertebral body. The arch of the medial pedicle wall, under which ad-