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Safety and Efficacy of Power-Assisted Pedicle Tract Preparation and Screw Placement

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Abstract

Study Design: Retrospective review of 1 surgeon's posterior spinal fusion cases.
Objectives: To assess the safety and efficacy of using power tools versus using manual tools to create pedicle tracts and place pedicle screws.
Summary of Background Data: This is the first study to report on the safety and efficacy of pedicle tract creation and pedicle screw placement using power tools.
Methods: The study included 442 cases and 6412 pedicle screws. The manual tool cohort included 159 cases (1,870 screws, January 1, 2004 to June 30, 2007). The power tool cohort included 283 cases (4,542 screws, January 1, 2008 to August 29, 2012). Patient charts and radiographs were reviewed. The researchers recorded the number of screws placed and their positions. Screws were classified as failed if the patient returned to surgery for revision or removal of the screw. Operating and fluoroscopy times were analyzed by cohort overall and for diagnosis-specific subsets.
Results: The incidence of injury resulting from pedicle screw placement was 0.00% (0 of 1,870) with the manual method and 0.02% (1 of 4,542) with power ($p = .5211$). One screw, placed with power, was assumed to have caused a minor hemothorax, which was successfully treated with a chest tube. There were no neurologic or vascular injuries or other complications attributable to a pedicle screw in either group. Screws placed with power were removed or revised because of problems attributable to the pedicle screw one-sixth as often as those placed using manual tools: 2 of 1,410 (0.14%) versus 8 of 948 (0.84%) ($p = .024$). Fluoroscopy times in the power cohort were two-thirds as long as those in the manual cohort ($p < .001$). Operating times were not significantly different ($p = .109$).
Conclusions: The use of power tools to create pedicle tracts and place pedicle screws was associated with shorter fluoroscopy times and a lower revision rate compared with using manual tools. Both techniques posed similar low risks of injury to the patient.

Keywords: Posterior spinal fusion; Scoliosis; Pedicle screws; Radiation; Power tools

Introduction

Among many surgeons, pedicle screws have become the preferred form of posterior spinal instrumentation when correcting spinal deformity [1-6]. Prior authors [7-9] have described techniques for the manual insertion of pedicle screws. Multiple studies have examined the safety of pedicle screw instrumentation [10-14]. No studies have evaluated the safety or efficacy of pedicle screws placed under power in the clinical setting.

Power surgical tools are being used with increasing frequency. Elliott [15] demonstrated that power tools reduce the time required to insert cortical bone screws without altering thread patterns or diminishing the surgeon's control of penetration. Ansell and Scales [16] demonstrated that the continuous rotation produced by a power drill requires less total torque than the intermittent rotation necessitated by hand tools. Cadaveric testing found that pedicle screws placed with power require 95% less surgeon work, are implanted 55% faster, and wobble 38% less during insertion [17].

A survey of the Scoliosis Research Society demonstrated that spine surgeons appear to be at increased risk of overuse injuries of the hand, wrist, shoulder, and cervical spine compared with the general population [18]. In addition, it has been reported that orthopedic surgeons receive

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more radiation than the general population from using intraoperative standard and mini c-arm fluoroscopy [19-22], which has been speculated to be associated with an increased risk of thyroid cancer [23-25]. Any change in technique that reduces surgeon musculoskeletal strain or radiation exposure could possibly reduce these health risks.

The purpose of this study was to compare the safety and clinical efficacy of pedicle tract preparation and screw placement using power tools versus using manual tools.

Materials and Methods

This was an institutional review board–approved, retrospective review of all patients undergoing posterior spinal fusion by 1 fellowship-trained, senior orthopedic surgeon. Consecutive cases at a single tertiary care children's hospital undergoing surgery from January 1, 2004 to June 30, 2007 and January 1, 2008 to August 29, 2012 were included if they had at least 1 pedicle screw placed. From July 1, 2007 to December 31, 2007, the surgeon was transitioning from the manual technique to the power technique and used a combination of the 2 techniques in those cases. Consequently, cases during the transition period were not included in either group for this comparison. Of note, although they were excluded from this analysis, there were no neurologic or vascular injuries from pedicle screws by either method during the transition period.

Patient charts were reviewed to identify age at surgery, gender, spinal deformity diagnosis, and previous history of spine surgery. Spinal deformity diagnoses were subcategorized into congenital, idiopathic, neuromuscular, spondylolysis/listhesis, traumatic, and "other." The "other" category included presentations associated with a variety of syndromes. The authors analyzed all consecutive cases in the study periods and completed a separate analysis of patients who had more than 2 years' follow-up.

Screw-related outcomes were identified from patient charts. These outcomes included injuries that occurred during screw insertion, unplanned returns to the operating room for screw revision or removal, the number of screws that required revision or removal (failed screws), and the method by which the screws failed. Although each case of screw failure was unique, the decision to return to the operating room was based on radiographic evidence of possible screw malposition or migration (screw pullout, fracture, or other loss of fixation). Some of these failures may have been discovered owing to the patient presenting with symptoms of pain or prominence, but the decisions to revise screws were based on concerning radiographic findings and pain was not necessarily present. Additional outcome measurements included the operating and fluoroscopy times of the operation during which the screws were placed.

Manual method

When placing screws using manual tools, the surgeon used a technique similar to previous literature descriptions [7-9]. The facet joints were excised and the cortical bone was removed with a high-speed burr at the entry point. A curvilinear (Lenke) probe was inserted to the desired depth. A ball-tip probe was used to check for any breaches in the pedicle tract. A tap was not normally used. The surgeon used the ball-tip probe to measure the depth of the tract and chose an appropriately sized screw. The screw was placed using a hand-powered screwdriver.

Power method

With the power method, the facet joints were excised and the cortical bone was removed with a high-speed burr at the entry point. A standard battery-powered orthopedic drill was used (Stryker, Cordless Driver 3, Kalamazoo, MI). The speed of rotation of the drill bit was regulated by the surgeon pressing on a button on the hand-piece of the drill. The pedicle tract was created using a variable-speed drill with a 2.0-mm drill bit (Fig. 1). The drill bit was rotated slowly, about 2–3 rotations/s so as to sense feedback of the cutting tips against

Fig. 1. Creating the pedicle tract using a power drill and a 2.0-mm drill bit.