Robotic-assisted Pedicle Screw Placement in Complex Spinal Surgery Cases: What Was Learned from our First 23 Patients

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Introduction: Surgeons’ interest is increasing in the use of image guidance and or robotics for the placement of spinal implants. The technology used in these systems is continually improving and may be particularly useful for patients with challenging anatomy. Only through careful clinical evaluation can its successful applications, limitations, and areas for improvement be defined. The purpose of this study was to prospectively review one clinic’s experience in a series of initial consecutive cases scheduled for surgery using robotic-assisted pedicle screw placement.

Methods: Data were collected for the consecutive series of the first 23 patients scheduled for posterior pedicle screw placement using robotic guidance at a single hospital. Notes from each case were reviewed by an independent researcher to indentify the diagnosis, number of levels operated, number of screws placed, and any complications or unanticipated events that occurred during attempted screw placement. The majority of the patients had idiopathic or degenerative scoliosis. Other diagnoses included kyphosis, Scheuermann’s kyphosis, ankylosing spondylitis, adjacent segment degeneration with stenosis, spondylolisthesis, and L5 spondylolysis.

Results: The robotic guidance was scheduled for use in 23 patients. In one patient with kyphosis and a body mass index of 45.0, an adequate fluoroscopic image used for registration could not be obtained in the operating room. In this case all screws were placed manually. In another patient with severe scoliosis and cerebral palsy, only two screws were placed using robotic guidance again due to inadequate fluoroscopic images used for registration. In the remaining 21 patients, placement of 232 screws was attempted using robotic assistance. Screws were successfully implanted in 86.2% (200 of 232) of attempts. Three screws (1.5%) placed using the robotic system were misplaced. All three presumably due to “skiving” of the drill bit or trocar off the side of the facet joint. One was repositioned using robotic guidance. Another had deviated superiorly into L4-5 disc space and was redirected manually through the same drill hole. In one patient a misplaced L4 screw was removed 4 days post implantation due to nerve irritation. The remaining 32 screws (13.8%) were converted to manual placement for a variety of reasons. Twenty additional screw placements were converted to manual due to problems with registration and/or suitable trajectory for placement. The remaining two screws converted to manual implantation were in a patient with an L5 spondylolysis in whom all attempts to seat the drill bit for “pars screws” failed due to mobility of the lytic segment. Of note, among the 32 manually placed screws, one screw (3.1%) was redirected due to mal-positioning.

Conclusions: Robotic-assisted screw placement was successfully accomplished in approximately 86% of attempts, with only 1% being misplaced despite the majority of patients in this series having significant spinal deformities. Intraoperative fluoroscopic imaging for registration is critical and was the limiting issue for some cases. “Tool skiving” was felt to be the inciting issue with the misplaced screws.