Robotic pedicle screw placement learning curve

Siddiqui et al., described the learning curve of pedicle screw placement using Robot-Assisted Spine Surgery (RASS) of an experienced neurosurgeon and two supervised neurosurgical fellows.

The first 120 cases of RASS at the University of Texas Health Science Center at San Antonio were assessed. Patient variables included age, body mass index (BMI), and indication for surgery. Intra-operative variables included the vertebral level of pedicle screw placement, number of screws placed by each operator, intraoperative blood loss, and operative time. Post-operative variables included Length of stay (LOS), discharge disposition, 30-day readmissions, wound complications, and hardware revisions. Screw accuracy was determined with image overlay analysis comparing planned screw trajectory on the navigation software to the intra-operative CT scan with final screw placement. 2-dimensional accuracy was determined for the tip of the screw, tail of the screw, and angle the screw was placed. The supervising physician and first fellow began utilizing the robot concurrently upon its arrival, while the second fellow began using the robot after the system had been in place for seven months.

Both experienced surgeon and first fellow displayed a learning curve and achieved statistically significant improvement of accuracy after 30 screws. The second fellow had significantly better accuracy than the experienced surgeon in his first 30 screws. There were no complications from hardware placement in either group. There were no returns to the operating room for hardware issues.

RASS is a safe, accurate method of pedicle screw instrumentation. This data shows similar learning

adaptation rates for the first fellow and the experienced surgeon. Techniques learned by attending were immediately transferable to a new learner, who was able to achieve a faster learning curve than both first fellow and experienced surgeon [1].

A major peak in screw inaccuracies occurred between cases 10 and 20, and a second, smaller one at about 40 surgeries. One potential explanation could be a transition from decreased supervision (unskilled but aware) to increased confidence of a surgeon (unskilled but unaware) who adopts this new technique prior to mastering it (skilled). Schatloet al., therefore advocate ensuring competent supervision for new surgeons at least during the first 25 procedures of robotic spine surgery to optimise the accuracy of robot-assisted pedicle screws [2].

Between June 2010 and August 2012, the senior surgeon (IHL) performed 174 posterior spinal procedures using pedicle screws, 162 of which were attempted with robotic assistance. The use of the robotic system was aborted in 12 of the 162 procedures due to technical issues (registration failure, software crash, etc). The robotic system was successfully used in the remaining 150 procedures. These were the first procedures performed with the robot by the senior surgeon, and in this study, we divided the early learning curve into five groups: Group 1 (Patients 1-30), Group 2 (Patients 31-60), Group 3 (Patients 61-90), Group 4 (Patients 91-120), and Group 5 (Patients 121-150). One hundred twelve patients (75%) had spinal deformity and 80 patients (53%) had previous spine surgery. The accuracy of screw placement in the groups was assessed based on intraoperative biplanar fluoroscopy and postoperative radiographs. The results from these five groups were compared to determine the effect on the learning curve. The numbers of attempted pedicle screw placements were 359, 312, 349, 359, and 320 in Groups 1 to 5, respectively.

The rates of successfully placed screws using robotic guidance were 82%, 93%, 91%, 95%, and 93% in Groups 1 to 5. The rates of screws converted to manual placement were 17%, 7%, 8%, 4%, and 7%. Of the robotically placed screws, the screw malposition rates were 0.8%, 0.3%, 1.4%, 0.8%, and 0%.

The rate of successfully placed pedicle screws improved with increasing experience. The rate of the screws that were converted to manual placement decreased with increasing experience. The frequency of screw malposition was similar over the learning curve at 0% to 1.4%. Future studies will need to determine whether this finding is generalizable to others [3].

References

1)
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