The Role of Training Level and Modality in Pedicle Screw Accuracy.

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Introduction

Evolving pressure on surgical education necessitates efficient learning of techniques and documentation of surgical proficiency, all within duty hours. There are few objective measures of surgical performance outside of a simulator setting. We evaluated the effect of training year using anatomic, percutaneous fluoroscopy guided and computer navigated techniques on the accuracy of pedicle screw placement to determine if different modalities may be better suited for different levels of training. We also sought to document the feasablity of measuring the breach rate for all members of our department to compare surgical proficiency with literature based standards.

Methods

All instrumented thoracic and lumbar cases performed at Detroit Medical Center by the Neurosurgery Service between August 2012 and June 2013 were included. Cases had hardware verified by post-operative CT a standard practice in our department. Hardware placement was graded according to (Mirza, Wiggins et al. 2003), grade 0 (within pedicle), grade 1 (<2mm breach), grade 2 (>2mm breach) , and grade 3 (extrapedicular). Pedicle screws were reviewed independently by a resident and attending surgeon. Rates of pedicle breach, EBL, length of case, pedicle size and pedicle starting point were all reviewed. Pedicles were analyzed on PACS system in axial views, using sagittal views to identify the correct level. All screws were placed with the patient in the prone position. Charts and statistics were generated using Microsoft Excel. T tests were utilized for statistical significance where appropriate. As we were expecting screws placed with fluoroscopy or computer navigation to have lower breach rates than anatomic screws 1 Tailed Tests were used. Pedicle screw starting point was determined by drawing a line down the center of the pedicle into the vertebral body on axial views. If the entry point of the screw was medial or lateral to this it was considered a medial or lateral starting point. Grade 2 and 3 breaches were utilized for calculating the breach rate because in the upper thoracic spine were the pedicles can be smaller than 5 mm, the smallest percutaneous screw is 5mm in diameter, thus a small degree of breach is inevitable.

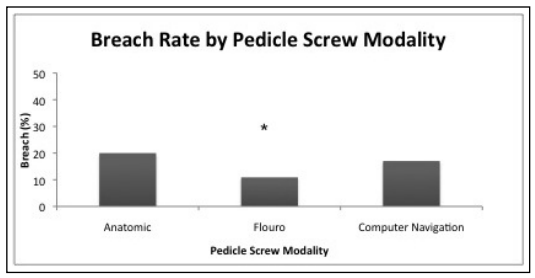
Results

Patient Demographics

A total of 306 pedicle screws were evaluated in 36 patients, 212 resident placed screws. The overall rate of accurate pedicle screw placement among residents defined as Grade 0 or 1 placement was 86.8% for residents. Average age of patients was 53 years old (20-73). 63.9% Femaies. Case breakdown is as follows: 50% decompression for metastatic tumor (bulk of percutaneous flouro cases), 20 % scoliosis/deformity, 30% trauma, degenerative, epidural abscess. Average pedicle size as follows: Upper Thoracic 5.7mm, Lower Thoracic 6.7 mm and Lumbar 10 mm.

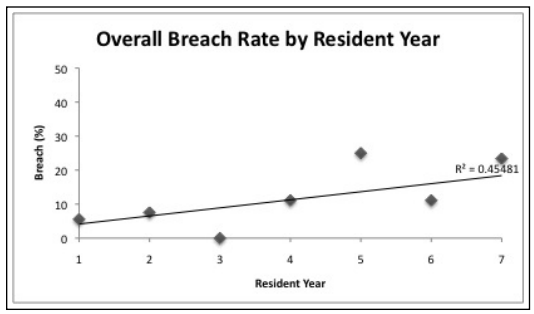
Breach rates are lower in image guided screw placement.

Overall fluoroscopically placed screws had significantly less breaches than anatomic screws 11% vs. 17% (p=.03) (figure 1). Each modality was between 15-20% breach rate. See Below. Resident breach rate was 13.2%. Grade 3 breach rate was 5 %. (16 screws). 10 of these screws were resident placed, and only 3 were medial breaches.

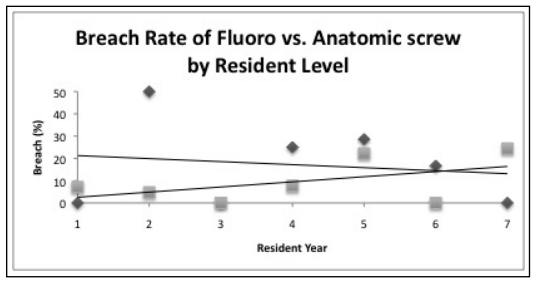


The higher level of resident training had more breaches.

Comparing breach rates by resident level an inverse trend between training experience and breach rate was observed., Among residents, the PGY 7 resident placed 47 screws with a grade 0/1 placement of 76%, compared to the PGY2 resident who placed 53 screws with a grade 0/1 placement of 92%. There is an inverse correlation between PGY year and pedicle placement accuracy (R squared 0.45). See below.



When breach rate by resident year was analyzed by individual modalities we found two different trends of performance depending on the technique. Anatomic screws (dark diamonds) trended towards improved accuracy as the PGY level increased, while fluoroscopic screws (lighter square) showed an inverse relationship between year and performance. See below.



Breach direction was related to modality not resident level

There was no significant difference in medial or lateral breach by resident level. However, fluoroscopy guided percutaneous screw placement resulted in significantly less medial breaches (20%) than anatomic (50%) and navigation placed screws (73%). Of all medial starts on the pedicle ,25% of screws resulted in grade 3 medial breaches and 18% of screws resulted in Grade 3 lateral breaches. No lateral starting screw resulted in grade 3 medial breach. Lastly, smaller pedicles are harder to cannulate. Pedicles < 5mm had 19% Grade 2/3 breach rate compared to pedicles >9 mm breach rate of 6%.

No screws had to be revised. There was a trend for spine trained supervising attendings (those with specific fellowship training) to have lower rates of breaches overall. Flouroscopy guided percuataneous screws trended towards having lower EBL (471 cc compared with 720 cc and 820 cc for anatomic and computer navigated), and shorter case times (4.7 hr) however these findings did not reach significance.

Conclusion, Discussion, and Caveats

--Neurosurgical Residents in training can place pedicle screws within acceptable literature standards (15-25% breach rate ,Guzey 2006).
--Senior level residents have a higher breach rate than junior level residents overall. This is likely due to less stringent allbeit still supervised training. This observation has been reported by others (Wang, Chin 2010). Likely contibuting to this observed breach pattern is a more hands on set up of AP/Lateral Flouroscopoy completed by senior residents for percutaneous screws.
--Percutaneous Flouroscopy guided screws resulted in significantly less breaches than the other two modalities and may represent a safer technique for junior resident screw placement while building the foundation for more advanced techniques.
--Not all residents placed computer navigated screws which were used solely for scoliosis and deformity cases. These cases tended to be longer with more difficult anatomy.

References

Guzey, F. K., E. Emel, et al. (2006). "Accuracy of pedicle screw placement for upper and middle thoracic pathologies without..." J Spinal Disord Tech 19(6): 436-441.
Mirza, S. K., G. C. Wiggins, et al. (2003). "Accuracy of thoracic vertebral body screw placement using standard fluoroscopy, fluoroscopic image guidance...." Spine (Phila Pa 28(4): 402-413.
Wang, V., C. Chin, et al. (2010). "Free-hand thoracic pedicle screws placed by neurosurgery residents: a CT analysis." European Spine Journal 19(5): 821-827.