Editorial

Editorial on "Increased radiation but no benefits in pedicle screw accuracy with navigation versus a freehand technique in scoliosis surgery"

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Spine surgery is a rapidly evolving field. Advancements in operative techniques, including the use of navigation, have allowed for reduced operative times, reduced blood loss, lower complication rates, and overall improvements in outcomes. Pedicle screw fixation has been available for several decades and is currently the cornerstone of spinal instrumentation. Although the free-hand technique is a widely adopted method for screw placement, it is operator and experience-dependent with risk of misplacement. Furthermore, misplaced screws may cause reduced biomechanical strength of the construct or injury to neurovascular structures or adjacent organs.

The use of three-dimensional intraoperative navigation emerged as a promising tool to improve screw accuracy, with accuracy rates of 89–97% (1). This method consists of obtaining intraoperative imaging (typically via a computed tomography scanner), uploading the data to a navigation system, and then using a navigated probe for screw placement. In their article "*Increased Radiation but No Benefits in Pedicle Screw Accuracy with Navigation versus a Freehand Technique in Scoliosis Surgery*", Urbanski *et al.* compare the freehand technique to the 3D navigation technique, assessing screw accuracy and total radiation doses in patients with spinal deformity (2). The study sample consisted of 49 patients (age range from 11 to 48 years) with progressive idiopathic scoliosis—22 in the freehand group and 27 in the navigated group. Patients with history of previous spinal surgery, non-idiopathic curves, and curves less than 40 or above 95 degrees were excluded. Pedicle breeches were evaluated with the Gertzbein and Robbins method: Grade 0= no pedicle wall breach; Grade 1= pedicle breech ≤2 mm; Grade 2= wall breech ≤4 mm; and Grade 3= complete wall breach >4 mm (3). The authors found an accuracy rate of 96% for both techniques (P=0.518); Grade 3 breeches were only seen in the freehand group but did not cause neurovascular injury and were immediately repositioned. On the other hand, patients in the navigated group received an average radiation dose of 1,071 *vs.* 391 mGy-cm in the freehand cohort (P<0.001).

Urbanski *et al.* should be commended for their efforts and publication. However, it is important to acknowledge the limitations in generalizing these findings, given that recent studies have suggested that navigated screws are in fact superior to freehand screws placement (4). Urbanski *et al.*'s study included both adolescent and young adult patients with idiopathic scoliosis undergoing first-time surgery. This is an important point given that the size of pedicles changes with age and thus could potentially lead to inconsistencies in measurements of screw placement accuracy; for example, a specific sized screw placed on a

larger pedicle (i.e., adult) may be less likely to breech than the same sized screw on a smaller pedicle in a younger patient. Thus, a generalization of the benefits of free-handed placement may not apply to other age groups.

We agree with Urbanski *et al.* that the utilization of 3D navigation for pedicle screw placement in young adults with idiopathic scoliosis undergoing first-time surgery may potentially lead to higher costs and unnecessary irradiation without a clear significant clinical advantage over the freehand technique. However, there are instances were navigation is, in fact, very useful, including patients with advanced degenerative disease, revision procedures, patients with complicated and severe deformity, minimally invasive spine surgery, and complicated spinal tumors.

Rajesekaran *et al.* recently published a series of 31 complex spine deformity patients (curves ranging from 60–104 degrees) who received a total of 452 pedicle screws, showing an accuracy rate of 96.2% with CT-guided intraoperative navigation (5). In oncology surgery, Bandiera *et al.* described their experience with seven patients with spinal tumors, in whom they utilized a navigation system both for screw placement and tumor resection. Twenty pedicle screws were placed in total and none of them required revision (6). Nasser *et al.* also published a multi-center study examining 50 patients who underwent biopsy and/or resection of spinal column tumors using image-guided navigation (7). The authors used navigation for tumor resection and instrumentation with favorable outcomes—there were no cases of neurovascular injury from screw placement (7).

Moreover, several studies and large meta-analyses have favored navigated screw placement compared to the freehand technique. Verma *et al.* conducted an analysis on 23 studies reporting on 5,992 pedicle screws, finding a statistically significant higher accuracy rate for navigated screws, but no significant difference in neurological injury rates between groups (8). Shin *et al.* performed a similar analysis in 2012 showing also a lower breech rate in navigated screws compared to freehand screws (6% *vs.* 15%) after comparing over 7,000 pedicle screws; however, no significant difference in reoperation rates were found (4).

One of the biggest challenges when performing systematic reviews and meta-analyses comparing the freehand and navigated technique is that patient populations are usually heterogeneous—children, adolescents, adults, idiopathic scoliosis, degenerative scoliosis, various screw sizes etc. Several analyses have shown that navigated screws may in fact have a higher radiographic accuracy rate, resulting in statistically significant differences (4,8). Nonetheless, while accuracy rates may be higher, a very small percentage of screws result in neurovascular injury or require revision from misplacement, posing the question of the clinical advantage of navigated screws.

Spine surgeons should know and master the freehand technique, as it remains the pillar of spinal instrumentation; this has become even more imperative as navigation becomes more and more common place in hospitals around the world. However, the training of spine surgeons may be affected as residents rely increasingly on new technologies to place screws, at the expense of learning the basics of proper free-handed screw placement. As the field continues to advance, the use of navigation and robotics will and should be embraced and utilized by surgeons (9). But with these technological advancements, it is fundamental for surgeons to use the necessary clinical and operative judgment to determine the role of the technologies at our disposition and their proper utilization while not neglecting the acquisition of the free-handed placement of screws.

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Footnote

Conflicts of Interest: Reza Yassari has a consulting agreement with Stryker. Other authors have no conflicts of interest to declare.

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