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The utilization of image-guided devices and robotic assistance in lumbar spinal fusion surgery have shown several advantages to patient safety and operative efficiency over the years. The accuracy of pedicle screw placement has improved dramatically with intraoperative image guidance compared with standard freehand techniques. Postoperative outcomes have also improved with such assistive technologies.[1] As the use of assistive devices in spine surgery becomes more popular, there still exists a significant cost barrier that prevents ubiquitous adoption of these tools. The authors of this study have provided a novel device that is simple to use and offers a cost friendly solution to reliable pedicle screw placement without compromising efficiency and potentially patient safety.[2]

This freehand navigation device is used to develop a trajectory for pedicle screw placement and requires the use of proprietary software run on an iPod touch with use of the iOS operating system's gyroscopic-on-chip technology. A preoperative supine lumbar MRI/computed tomography (CT) scan can be merged with an intraoperative true lateral lumbar x-ray to activate the image guidance. The patient's bony anatomic landmarks are then used for the starting point of the guided screw trajectory. The authors of this study have confirmed the excellent and reliable accuracy of pedicle screw placement comparable with current intraoperative image-guided techniques.

Driver et al[2] have also noted that the immediate advantages in using this mobile device in placing pedicle screws are reduction of visual obstruction and minimal loss of attention intraoperatively while optimizing operative workflow. There is no additional personnel equipment or monitors required for this device. Although this device may be directed toward facilities without a large operating budget, the lack of validation and active feedback from ancillary operating room personnel can be lost. In addition, "hands-on" teaching and secondary learning may be impeded by individuals who do not have direct visualization of the device or are not scrubbed into the case. Regarding patient safety, relative to the available technologies for reliable and accurate pedicle screw placement, many of the standard techniques offer percutaneous screw placement. The tool discussed in this article requires the gyroscopic navigation that is registered on the bony entry point, which would also require direct visualization. When fully exposed, care should be taken to avoid proximal facet joint violation and, ultimately, adjacent vertebral instability.[1] Although there are studies demonstrating no clinically significant differences between minimally invasive surgery and open transpedicular lumbar interbody fusion cases, a percutaneous-based image-guided system would offer improved perioperative outcomes—well documented with minimally invasive surgery cases.[3]

A minor technical drawback of this device is that it relies on preoperative imaging, which may vary from the patient's anatomy when positioned intraoperatively. To mitigate this issue, this device offers the ability to merge intraoperative lateral x-rays to the preoperative scans. Although this can accommodate for some minor changes dependent on patient positioning, it is still unknown how reliably such changes can be accounted for in vivo. In addition, in the case of patients with morbid obesity and/or low bone density, the potential loss for image quality on intraoperative radiographs may represent as a technical barrier.

Without the use of intraoperative fluoroscopy or CT scans, verification of pedicle screw placement will be difficult to assess. Furthermore, pedicle screw misplacement has been reported to be fairly common, up to 50% in some cases.[1] In a systematic review and meta-analysis on intraoperative navigation modalities used on spine fusion surgery, Du et al[4] noted that CT-guided navigation was more accurate than 2-dimensional fluoroscopy (RR = 0.49) but less accurate than 2-dimensional vs 3-dimensional fluoroscopy systems (RR = 0.31). Three-dimensional fluoroscopic navigation was

superior to preventing pedicle violations as well. The authors of this study have noted achieving a similar success rate as navigated screw placement, compared with freehand techniques again necessitating further validation studies in live (rather than cadaver) patients.

Image guidance and robotic assistance have also demonstrated their value when dealing with complex scoliotic cases or instrumentation within the rostral thoracic spine. In a meta-analysis evaluating the accuracy of various assisted/nonassisted pedicle screw techniques by Perdomo-Pantoja et al,[5] screws placed in the thoracic spine were significantly less accurate than when placed in the lumbar spine. With the change in pedicle diameter and trajectory throughout the thoracic spine, the utilization of the author's device would need further studies to determine the accuracy for extensive thoracolumbar constructs, and unplanned intraoperative shift is not appreciated in cadaver models.

Aside from the immediate benefits of this mobile-assistive device, such as low cost, interoperative efficiency, and wide variability, there are further advantages to this technology—mainly improved patient safety and surgical outcomes similar to those achieved with standard image-guided systems for pedicle screw placement. Driver et al[2] have also created a unique technological innovation in spine surgery that will be ideal for resource-deprived countries or institutions with stringent operating room budgets. Such a device can ultimately decrease the complications associated with pedicle screw placement and ultimately improve postoperative patient outcomes. Of course, with any cadaveric study, there are inherent differences not accounted for when performed in vivo. We congratulate the authors' efforts to provide a novel, cost-effective imaging modality and surgical technique with broad applicability. This technology warrants further investigation on human subjects for adaptation into clinical practice.

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