



On Patient Safety

Safer Operations, But Worse Surgeons?

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Remember MapQuest, the amazing website that allowed its users to download and print directions to and from anywhere? When was the last time you physically printed out directions? Doing so has all-but been made obsolete with the

Note from the Editor-in-Chief: We are pleased to publish the next installment of “On Patient Safety” in Clinical Orthopaedics and Related Research®. The goal of this quarterly column is to explore a broad range of topics that pertain to patient safety. We welcome reader feedback on all of our columns and articles; please send your comments to eic@clinorthop.org.

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development of real-time Global Positioning Satellite (GPS) applications like Google Maps and Waze. Appliances and devices quickly become antiquated as a better, more efficient model (or smartphone application) is brought to market. The same is true for technology in healthcare today. It is challenging to keep up with advances in medicine, unless they are in one's own area of interest.

In the spine world, pedicle screw fixation has enabled surgeons to achieve stability and enhance fusion formation. Though the development of the pedicle screw instrumentation is in itself and important progression of surgical technique, it does carry some risk of injury to nerve roots and blood vessels. However, technological advances such as three-dimensional (3-D) navigation and intraoperative advanced imaging are changing our ability to place spinal instrumentation safely. Technology can also enable us to better perform common surgical procedures, potentially decreasing complications. There is no doubt that technology has and will continue to expand what we can do surgically and how well we do it.

Seasoned surgeons may reminisce and scoff at the use of all this technology. But when all talk is done, everyone will agree that regardless of

our respective dependence, technology on the whole, has only improved the safety of surgery. And in many cases, technological advancements have become the standard of care: Arthroscopy, and intraoperative imaging to name a couple.

Despite all of these beneficial aspects, there is potential for danger: Complacency and overdependence.

I was once instructing a fellow on pedicle screw placement in the lumbar spine using C-arm fluoroscopy. He was aiming a little too superiorly toward the endplate of the vertebral body. Instead of specifically telling him which direction to move his hand, I told him to adjust his angle assuming he would figure it out. To my surprise, he shifted his hand caudally, worsening the trajectory, and called for an image. I assumed that he had become momentarily disoriented. However, he then moved his hand even more caudally and called for another fluoro image. He repeated this a few more times while moving his hand in seemingly random directions before checking the image. I watched this unfold, disturbed by the lack of thoughtfulness. He wasn't even looking at the patient; he was watching the fluoroscopy screen, relying on it to guide him. Instead of actually thinking

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about the anatomy and what he was doing, he was lazily relying on the imaging to show him the way. Because of this, I chastised him for his overdependence on technology, rather than thinking about what he was doing.

Although this example was with a fellow who was still learning, this dependence on technology is not limited to trainees. Recently, a colleague of mine cancelled a single-level routine spinal fusion procedure because the 3-D navigation system was not available. For that surgeon, it was safer to cancel the procedure rather than perform it with other, established, techniques. While it is laudable that the surgeon recognized his own limitations, what would he have done if the situation was urgent or emergent and he could not easily delay? By adopting these technological advances, are we allowing our surgical skills to erode? Is technology making us worse surgeons?

To some extent, yes. I recently watched a resident ream an acetabulum for a total hip replacement using robotic guidance. Instead of taking into account patient position, and assessing tactile and visual feedback, his attention was entirely on a screen waiting for the computer to tell him he had adequately reamed. I also watched a junior resident place thoracic pedicle screws using robotic guidance. Instead of reviewing his anatomic landmarks and engaging in 3-D spatial reasoning, he simply did

what the computer told him to. In both of these examples, the instrumentation was placed perfectly. The more technology replaces skills we have learned, the more likely it is we will forget those skills, or worse, never learn them at all. Just as my natural sense of direction probably has eroded because of GPS, I fear surgical skills will similarly diminish because of technology. A great surgeon can do the same thing many ways. Great surgeons have a Plan A, B, C, and Z in their armamentarium. A great surgeon can still perform the surgery when the unexpected occurs: instruments break, microscopes malfunction, imaging is unreliable. However, the more technology becomes consistently reliable, the less necessary these alternative methods and skills become. The more technology becomes consistently reliable, the less future generations of surgeons will need to learn previous techniques.

Whether we like it or not, because of technology, the role of the surgeon is increasingly becoming commoditized. It is entirely feasible (and expected) that future surgeons, with less technical skill and knowledge, but with the assistance of technology, will perform the same procedures that only a relative minority of surgeons could perform before. And while this reality may make us feel less unique as specialized surgeons, we need to ask what the effect of technology on patient care is?

Even though I believe I am a better surgeon for not relying solely on technology, are my outcomes better than if I were using technology routinely? Spine surgeons at the University of British Columbia examined this question [1]. They compared pedicle screws placed using conventional fluoroscopic guidance to screws placed using newer CT-based navigation. What they found was that the accuracy rate in the conventional group was 86.9% as compared to 95.2% for the CT navigation technique. Importantly, the reoperation rate because of these screws was 6% for the conventional group and less than 1% for the CT group. Finally, because of the added cost of revision, they projected that CT navigation technology becomes cost effective for an institution performing more than 254 surgical procedures a year.

I have a pretty healthy ego about my own surgical prowess, but I know I have revised some of my own pedicle screws. Every (honest) spine surgeon will tell you the same. It happens. From a patient-safety perspective, is it worth it to me to adopt this technology if it will reduce my reoperation rate from 6% to 1%? It's hard to argue against that kind of benefit. The British Columbia study suggests that it may be worthwhile to adopt these guidance technologies not only because of cost, but most importantly because of improved patient safety.

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Technology has and will continue to improve accuracy, efficiency, and safety of surgery. Eventually, when outcomes are demonstrably superior, technological advances will become the standard of care. We've seen it happen already. If there is no intraoperative imaging available, am I really going to try and fix that complex tibial plateau fracture? If there are no functioning arthroscopes in the hospital, am I going to convert my ACL reconstruction to an

open procedure just to get it done? If there is no neuro-monitoring available, am I really going to go ahead with my cervico-thoracic osteotomy? In all of those instances, for the safety of the patient, the answer is no. But where we can, we should have alternatives available. After all, whether it's the GPS that goes down, or whether it's the robotic guidance that crashes intraoperatively, it is always good to know several ways to get home.

References

1. Dea N, Fisher CG, Batke J, Strelzow J, Mendelsohn D, Paquette SJ, Kwon BK, Boyd MD, Dvorak MF, Street JT. Economic evaluation comparing intraoperative cone beam CT-based navigation and conventional fluoroscopy for the placement of spinal pedicle screws: A patient-level data cost-effectiveness analysis. *Spine J.* 2016;16:23–31.