Computer-Assisted Navigation: A Way to Level the Playing Field?

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As a shoulder and elbow fellow learning the art of arthroplasty, it has become quickly apparent that experience is perhaps the most valuable tool of a shoulder surgeon.

Unfortunately, this is a tool that cannot be handed over as easily as a scalpel, and requires many years of successes and failures to obtain. The function of technological advancement in modern day surgery should be to make difficult cases easier, to level the playing field for those who lack experience and/or talent, and to generate consistent results for our patients.

Computer-assisted navigation is a very broad term used to describe techniques that enhance visibility of surgical anatomy and improve accuracy by means of robotic devices or navigation systems. This technology links the osseous anatomy of the patient to a virtual, often radiographic, representation that allows tracking of surgical instruments.[1] Despite more than 10 years of use in orthopedic surgery, computer-assisted navigation is an example of an innovative technology without a defined role in clinical practice. Studies in knee arthroplasty had mixed conclusions regarding the utility of navigation in primary arthroplasty.[2-4] As this technology continues to try and find a suitable role in orthopedic surgery, it is unlikely to be cost-effective for every arthroplasty case and for every surgeon. Studies evaluating the role of computer-assisted navigation for complex cases and for inexperienced surgeons are lacking.

It is well known that proper implant positioning is one of the primary tenets of achieving a well-functioning and long-lasting shoulder arthroplasty.[5-6] Proper implant positioning requires knowledge of the preoperative geometry of the glenoid and the humerus, and is often obtained by plain radiographs and computed tomography (CT) scans. The surgeon must be able to translate these bloodless, soft-tissue deficient images from a computer screen into 3-dimensional, practical application in an operating room where the position of the scapula and the glenoid orientation cannot be perfectly controlled. Most significantly, glenoid preparation and resurfacing can often be complicated by limited exposure and a lack of reliable anatomic landmarks.[7] Achieving proper glenoid version and identifying the glenoid centerline can be challenging for the inexperienced eye. Iannotti and colleagues[8] have shown that even small degrees of glenoid deformity can make it difficult for experienced surgeons to place the glenoid component within 5° of the ideal position. Other researchers have shown that very small variations in glenoid version can result in significant glenohumeral subluxation and shift of force vectors from the glenoid center.[9] The potential implications for malposition are concerning.

As the majority of shoulder arthroplasties are done by surgeons who perform the procedure only once or twice a year,[10] inexperience is the norm, not the exception. In addition, with the projected rise in shoulder arthroplasties,[11] there will be a corresponding rise in revision burden. Surgeons will be faced with issues of deformity and bone loss in the setting of revision total and reverse shoulder arthroplasty. In these situations, it can be critical to locate and place the glenoid component, baseplate, and/or screws in the area of optimal bone stock, a task that can be challenging even for the most experienced and talented surgeons.

Perhaps computer-assisted navigation presents a means of leveling the playing field for inexperienced surgeons and simplifying complex cases for experienced surgeons.

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Am J Orthop. 2012;41(11):E155-156.

Kircher and colleagues[14] conducted a prospective-randomized study and showed improved accuracy in glenoid positioning in the transverse plane using intraoperative navigation; however, small patient numbers and short follow-up limited the conclusions of the study. Similarly, the few cadaveric and clinical studies using navigation in total and reverse shoulder arthroplasty have shown benefits in terms of implant positioning accuracy,[12-16] but it remains unclear whether the added cost and time associated with computer-assisted navigation results in substantially better functional outcome or implant survival.

Perhaps navigation can serve as a form of training wheels that minimizes complications during the surgeon's learning curve, yielding consistent results for those of us who are new to the field or for those who do not perform shoulder arthroplasty with great regularity. For those experienced shoulder surgeons who undertake complex primary and revision cases with significant deformity and/or bone loss, navigation may be a useful tool to optimize glenoid and humeral preparation, implant positioning, and fixation. It is possible that when used selectively, navigation will prove to be a clinically beneficial tool with a more defined role in orthopedic shoulder surgery. Well-controlled study in a cohort of inexperienced (ie, newly trained) surgeons may provide insight into the true benefit of this technology.

Author's Disclosure Statement

The author reports no actual or potential conflict of interest in relation to this article.

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