The Use of Computer Navigation and Patient Specific Instrumentation in Shoulder Arthroplasty: Everyday Practice, Just for Special Cases or Actually Teaching a Surgeon?

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The efficacy of these systems at improving radiographic outcomes has been investigated in a number of controlled and uncontrolled studies, with varying sample size, methodological quality, and results (5, 6).

Positioning of the glenoid component is one of the most challenging steps in shoulder arthroplasty, and prosthesis longevity is considered highly dependent on accurate positioning (5, 6). This is very important due to variations in scapula-humerus morphology. Surgical navigation and patient-specific instruments for glenoid implant positioning in anatomic and reverse total shoulder arthroplasty are in last years under observation and discussion (6).

Navigation is speeding up the learning curve (5), and what afterwards? Should it be used afterwards, for every case or only for special cases (more difficult ones: fractures, revi-
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A lot of work should be done, in order to give clear instructions or maybe guidelines regarding the use of navigation and PSI in shoulder arthroplasty. Further controlled long term clinical studies are needed to find a conclusion.

Moreover, computer-aided shoulder navigation is especially useful in situations where normal anatomy is distorted, such as with fractures, revisions, and glenoid wear or dysplasia (8).

Intraoperative navigation with patient specific instrumentation (PSI) improve the surgeon’s accuracy. Disadvantages of computer aided surgery are primarily related to the cost of the hardware and software (5). There is also a greater time requirement necessary for training and use of the planning software compared to traditional techniques, as well as the longer execution of the navigated surgery.

Every shoulder arthroplasty requires a unique performance due to patient’s unique anatomy of the shoulder. Screw length is important to maximize the bicortical engagement and navigation helps to achieve this in the most adequate way. This might lengthen the stability and longevity of prosthesis. Performance should be different as little as possible from the preoperative plan.

Standard instrumentation (SI) for glenoid positioning in total shoulder arthroplasty is inaccurate. However, the clinical significance of this has not been well established (6). Navigation system and Patient-Specific Instrumentation improve glenoid positioning outcomes, but with significant heterogeneity of results across studies.

2. OUR OPERATING TECHNIQUE - NAVIGATION WITH AN INDIVIDUALIZED (PATIENT PLUS PROSTHESIS SPECIFIC) PRINTED JIG

Every navigation starts with an appropriate preoperative planning (Figure 1). Navigation is just a tool for precise execution of our planning. The whole process starts with a Computer Tomography (CT) or CT artrography. Once we have a CT scan, we perform a 3D reconstruction of the joint. In case of artefacts produced by a radiographic contrast, those artefacts are removed by a special software, so the bone is extrapolated. Same procedure can be applied in case of CT performed on bone with metal implant. Once we have a 3D model of glenohumeral joint, we firstly calculate the inclination and version of articular surface. Chosen glenoid component is virtually implanted.
has shown superiority to standard instrumentation (SI) (12). Plan with a greater degree of accuracy and precision and instrumentation allow surgeons to execute the preoperative plan. Two decades (9-11). The evolving field and present topic in education over the past disciplinary field. Additionally, artificial intelligence (AI) is happening? Human-computer interaction (HCI) is a multi-disciplinary field. What is the goal of computer-assisted surgery (navigation) is to increase surgical accuracy and reduce the chance of malposition. Computer-assisted navigation allows surgeons to obtain real-time feedback, while decreasing the potential intraoperative errors, in order to make the adequate prosthesis placement (16). With prior surgeon training, after 8 operative cases surgeons achieve proficiency in intraoperative computer navigation of the glenoid component, although differences in time are most likely due to individual case complexity. However, the study was supported by Exactech™ and its products were used in the study, which must be taken into consideration. Moreover, surgeon’s previous experience with navigation may shorten the learning curve for navigation in new joint, and this was also presented as one of the limitations of the study (15).

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3. DISCUSSION
Learning curve is difficult in life-critical areas (e.g. medicine), where the required level of expertise is high, and students need to spend a considerable amount of time in operation rooms or using training stations (8).

Cadaver practice with NAV and PSI should be prerequisite for performing the surgery on patients. Is it always happening? Human-computer interaction (HCI) is a multi-disciplinary field. Additionally, artificial intelligence (AI) is evolving field and present topic in education over the past two decades (9-11).

Intraoperative guidance technology in the form of computer-assisted surgery (navigation) and patient-specific instrumentation allow surgeons to execute the preoperative plan with a greater degree of accuracy and precision and has shown superiority to standard instrumentation (SI) (12). Heterogeneity is high in studies that include different positioning systems (NAV, PSI and SI). Heterogeneity is due to differences in surgical technique, implants, surgeon’s expertise, radiographic image analysis technique. Clinical studies have shown that malposition is common in failed TSA (12), and that malposition is associated with reduced range of motion (13) and increased radiolucent lines (13, 14).

Simply written, critical, future-oriented paper by Porcellini presented up-to-date discussion with precise comments regarding the technology applications in shoulder arthroplasty. Some surgeons, especially experts and skilled ones, will probably consider CAS a waste of time and not necessary. However, similar concerns are usually raised when new technologies are introduced into surgical practice (5).

Alongside the pre-operative and intra-operative assessment, the post-operative follow-up should also be done. On the humeral side, retroversion and the contact point with the glenoid component should be studied for complete navigation in the future; the length and lateral off-set of the humeral component need to be properly planned, to avoid over-tensioning of the plexus, cuff or remaining cuff and deltoid (5). With prior surgeon training, after 8 operative cases surgeons achieve proficiency in intraoperative computer navigation of the glenoid component, although differences in time are most likely due to individual case complexity. However, the study was supported by Exactech™ and its products were used in the study, which must be taken into consideration. Moreover, surgeon’s previous experience with navigation may shorten the learning curve for navigation in new joint, and this was also presented as one of the limitations of the study (15).

The future high level studies should give the answer about the use of navigation and PSI, while taking into consideration functional outcome, prosthesis longevity, cost and surgical time. No studies identified in the literature search directly compare NAV to PSI for shoulder arthroplasty (6).

It is impossible to say whether the prosthesis for the determined (single) patient would have better clinical results and prosthesis longevity with or without navigation with PSI - because once the prosthesis is implanted, there is no way back. So, it is impossible to make such studies. Many studies suggest that better imaging results potentially lead to better clinical results and prosthesis longevity. However, the proposed benefits of the technology applications including improved glenoid survivorship, reduced revision arthroplasty rate and cost-effectiveness have not yet been demonstrated clinically (17). The end point of correction for the glenoid wear in shoulder arthroplasty is controversial, but anatomic glenoid component positioning.
is likely to improve long-term survivorship of the total shoulder arthroplasty (17).

4. CONCLUSION

The use of navigation systems and PSI should be clinically proven in the shoulder arthroplasty. Independent experts’ opinion and independent high level studies lack at the moment. There will be still a lot of talk regarding this topic in future.

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