Editorial Commentary: Assistive Technologies for Hip Arthroscopic Cam Resection Will Improve Diagnostic and Surgical Accuracy: Desperately Needed and Here to Stay

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Abstract: Hip arthroscopy is technically demanding and presents a steep learning curve. Joint access and maneuverability of surgical tools are impeded by a large soft-tissue envelope. Furthermore, cam resection is challenging owing to the small size of the lesion and the difficulty in delineating what is normal and where the cam starts. Thus, the number of incomplete resections is high and represents the bulk of indications for revision hip arthroscopy. The search for assistive technologies to improve on diagnostics and surgical accuracy is consequently substantial and unquestionably needed. Intraoperative feedback will improve our resection accuracy while decreasing the learning efforts of both expert and novice surgeons.

See related article on page 3371

It is without any doubt absolutely spectacular how a small lesion like a cam can so rigorously demolish the acetabular cartilage at such a very young age. In that observation also lies the terror for its treatment: its small size. We have seen adolescents—in whom we were even in doubt on the clinical significance of their cam—with nearly complete delamination of the acetabular cartilage on arthroscopic inspection.

With an average joint space of around 4 mm, any bump exceeding that size is plainly physically unable to enter the joint. Beyond this size, it will cause hinging or a pincer-type pattern of damage, predominantly consisting of edge loading[1] and labral tearing[2,3]—a pattern that we know to be less devastating to the internal joint as reflected by a lower association with osteoarthritis in the longer term. We strongly believe that the threat therefore lies in the aspherical portion of the cam below that size because it has the potential to engage within the joint—basically, the aspherical portion that is the hardest to delineate by simple eyeballing. Hence, assistive technologies are needed both at the diagnostic level and during the actual surgical procedure.

The first experiments with assistive technologies for the diagnosis and treatment of femoroacetabular impingement already date back from way before 2010.[4] The first step consisted of developing diagnostic tools simulating impingement-free range of motion and the extent of morphologic anomaly.[5] Later, these evaluations were transferred into the operating theater using—whatever available—navigation systems.[6] At that time, we simply copied the available knowledge on computer-assisted and -navigated surgery to the case of hip arthroscopy. Yet, as correctly stated by Looney, Wichman, Parvaresh, Alter, and Nho[7] in their article "Intraoperative Computer Vision Integrated Interactive Fluoroscopy Correlates With Successful Femoroplasty on Clinic-Based Radiographs," this occurred at the cost of increased radiation and additional surgical manipulation, such as the installation of skeletally based referencing systems.[8] Personally, we gave up using navigation around 2016. Patient setup and installation were horrible. The technical skills required to operate the 3-dimensional fluoroscope and navigation software impeded routine wise use by operating room personnel

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and nurses. Yet most important, we had learned our lesson. What navigated hip arthroscopy mostly added to our practice was the feedback it provided during the procedure on what we were doing as opposed to what we thought we were doing.

It is generally acknowledged that hip arthroscopy has a steep learning curve and that incomplete resection is the most frequent reason for failure and revision arthroscopy.[9,10] Moreover, the incidence of primary and revision hip arthroscopy is on the rise, as is the number of surgeons performing both.[11,12] In response, several simulator and training opportunities have been conceived.[13,14] Nonetheless, nothing compares to onsite training and real-time feedback. Intraoperative feedback improves our resection accuracy while decreasing the learning efforts of both expert and novice surgeons.[15] Any application that achieves this and is simple to use has a great application potential.

The methodology presented by Looney et al.[7] clearly is an example of such and, therefore, a significant step forward. It overcomes the drawbacks of the old approaches: the need for adjuvant imaging and additional surgical handling to attach an external reference system. It can be expected that more assistive technologies that are dedicated to the specific challenges of hip arthroscopy, accurate and simple in use, will follow in the future. We personally expect several advances to emerge from deep learning applications.[16] In particular, in the field of clinical imaging and video analysis, these technologies have exploded with unlimited applications being developed. Synthetic computed tomography images from magnetic resonance imaging scans can be provided for planning purposes; 2-dimensional fluoroscopy with matching 3-dimensional models can be provided. Even real-time analysis of the arthroscopic video images and markerless registration are among the options.

In summary, the future looks bright, both for the patient and for the surgeon. Assistive technologies for arthroscopic cam resection are definitely warranted; they are evolving, and without any doubt, they are here to stay.

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