Use of Intraoperative Technology to Perform a Cam Resection During Hip Arthroscopy for Femoroacetabular Impingement Syndrome

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Background: The learning curve for the surgical treatment of cam deformities in femoroacetabular impingement syndrome (FAIS) presents a challenge for young or inexperienced surgeons, with the leading cause of failed hip arthroscopy being incomplete resection. Historically, alpha angle measurements are typically used perioperatively to both diagnose cam deformity and evaluate the adequacy of cam resection. The computer-assisted Styker HipCheck system offers the surgeon real-time alpha angle measurements, assisting with the execution of cam resection.

Indications: The indication for use is any hip arthroscopic procedure for femoroacetabular impingement requiring osteochondroplasty of cam deformity. Advantages of the HipCheck system include shortened operative time; reduced risk of inadequate or over-resection; accelerated learning curve; no requirement of preoperative computed tomographic imaging or pre-planning; being noninvasive, portable, and not requiring additional instruments; increased patient and surgeon satisfaction; and allowance of repeated quantitative and visual assessment, which is particularly beneficial for more difficult regions, such as posteromedial and posterolateral, to view the femoral head/neck.

Technique Description: Briefly, after intra-articular procedures are complete, the peripheral compartment is accessed. We prefer a T-type capsulotomy. Next, the cam deformity is registered on Stryker HipCheck software, automatically calculating alpha angles as the hip is dynamically moved through 6 registered positions. A standard cam resection is then performed. Once complete, the hip is dynamically assessed and again registered with the HipCheck system in the same 6 positions to ensure adequate resection has been performed.

Results: When comparing patients with FAIS undergoing computer-guided resection or standard resection, both surgical interventions demonstrated successful reduction in alpha angle and no difference in degree of resection. In addition, the various computer-guided views exhibited good correlations to clinical radiographs.

Discussion: The HipCheck intraoperative system allows the surgeon to evaluate the adequacy of cam resection through the use of automated alpha angles. Furthermore, the system offers instantaneous feedback of cam resection at any desired position of the hip. This intraoperative technology may offer less experienced surgeons an aid when performing hip arthroscopy for cam resection in the setting of femoroacetabular impingement.

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Keywords: hip; arthroscopy; femoroacetabular impingement; computer-assisted; intraoperative

VIDEO TRANSCRIPT

In this video, we will discuss the use of intraoperative guidance for cam resections during hip arthroscopy for femoroacetabular impingement syndrome (FAIS).

The authors' disclosures are listed here. Of note, the senior author is a consultant for Stryker but received no support for the creation of this independent video.

Femoroacetabular impingement syndrome is becoming increasingly recognized as a cause of hip pain and is more common in women. The pathology stems from cam impingement, or asphericity of the femoral head or head-neck junction, or pincer impingement secondary to acetabular overgrowth, or a combination of a cam and pincer impingement.[3,5] These bony deformities result in mechanical

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impingement that contributes to soft tissue injury such as acetabular labral tears and cartilage injuries.[3,5] Patients present most traditionally with groin pain, but may also present with patterns laterally or posteriorly. Patients may have an abnormal gait or limp, and pain is typically reproduced with passive flexion adduction and internal rotation. Their motion may be limited by pain or the impingement itself.

After conservative measures fail to improve pain and symptoms, surgical treatment of FAIS is typically performed with modern hip arthroscopy techniques. The learning curve is challenging and the leading cause of failed arthroscopy is incomplete cam resection[1,8]; the alpha angle as shown on the right is the primary radiographic measurement to assess deformity and resection. Incomplete resection continues to have higher intra-articular contact pressures.[9] On the other hand, over-resection is rare, but does increase risk of drastic complication of femoral neck fractures.[10] Therefore, an intraoperative guidance system called HipCheck by Stryker (Kalamazoo, MI) has been developed that helps guide the surgeon with live feedback with alpha angle measurements on intraoperative fluoroscopic images to assist in cam resection.

The HipCheck system works live intraoperatively on fluoroscopic images. The system automatically calculates alpha angles and displays them to the surgeon. There are several advantages that may be useful for both the young, inexperienced and experienced hip arthroscopist.[4] This system can be effectively and easily implemented into the surgeon's and operative workflow, and it does not require pre-planning. The system itself is small, portable, and non-invasive, and it offers the surgeon easy access and direct feedback during the procedure. The system reduces the risk of under-resection and limits the fear of over-resection, especially for those with less experience, as it provides both quantitative and visual measures for adequate resection. The intraoperative guidance can increase satisfaction of both the surgeon and the patient. After resection, any imaging obtained by the system during surgery can be used to educate the patient, exemplifying what exactly was done during the procedure. Finally, the system assists in reducing the learning curve of the young surgeon and helps move education forward.

The 6 dynamic positions measured allows the surgeon to adequately resect the cam deformity not only in the easier sections of the femoral head to visualize (such as anterior) but in the more difficult areas as well (such as posterolateral and posteromedial), providing a template for appropriate resection depth.

Limitations and pitfalls of the system should also be noted. First, adequate connection between the fluoroscopic machine and the HipCheck system should be ensured prior to the procedure, as improper connection may limit real-time feedback during the resection and delay operating time. Second, the software assesses the alpha angle in 6 different dynamic positions of the hip. The surgeon must strive to achieve these same 6 positions both pre- and post-resection, and the inability to obtain similar views may result in ineffective resection. The system relies on adequate fluoroscopy. Surgical instruments superimposed on the femoral head-neck interface during resection may have a negative impact on readings, and the surgeon may need to retract the instruments to obtain accurate alpha angles. Finally, specifically for an inexperienced surgeon, failure or absence of the system may lead to a feeling of blindness.

The case we are presenting is a 27-year-old woman with deep groin pain rated 6/10, worse with weightlifting, running, and activities of daily living. She has associated stiffness and inflammation, and physical therapy did not relieve symptoms.

Examination revealed a non-antalgic gait, extension of 0°, flexion of 110°, external rotation of 30°, and internal rotation of 0°. She had pain with flexion, adduction, and internal rotation testing, and the remainder of the examination was within normal limits.

Radiographic imaging revealed cam deformity, and magnetic resonance imaging (MRI) revealed an acetabular labral tear.

Here are the preoperative radiographs demonstrating the cam deformity, best appreciated on the Dunn lateral on the far right.

Here are the MRI coronal, axial, and sagittal slices demonstrating her labral tear.

Indications and relative contraindications for hip arthroscopy and osteochondroplasty are listed here.

We will now review the surgical technique.

The first step is obtaining adequate peripheral compartment exposure.

After intra-articular surgery including labral repair is complete, we proceed to the peripheral hip compartment. We perform a debridement in the anterior compartment and a T-type capsulotomy, as seen here, with traction sutures to improve visualization and instrumentation. The traction sutures are passed on either side of the vertical T to allow access along the femoral neck.

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Next, the deformity is registered on Stryker HipCheck software.

Dynamic evaluation of the hip is performed and fluoroscopic images are taken. To do this, the C-arm is positioned at 15° cephalad tilt and 15° oblique to the hip of interest. A fluoroscopic image is first taken with the hip in neutral, and the midpoint of the femoral neck is selected on the system. Then, 6 fluoroscopic images are obtained. With the hip in 0° of flexion, an image is taken at 30° internal rotation, neutral rotation, and 30° external rotation. With the hip in 50° of flexion, an image is taken at neutral rotation, 40° external rotation, and 60° external rotation.

By simple touch screen navigation, the surgeon identifies the midpoint of the femoral neck and head on a fluoroscopic image with the hip in the neutral position. The software registers pre-resection data and automatically and quickly calculates alpha angles at various positions of hip flexion and rotation, as shown here. These 6 images and alpha angles can be referred to throughout the resection, which offers a benefit over relying on visualization and interpretation through fluoroscopic imaging alone.

In addition, at any time during cam resection, additional fluoroscopic images can be obtained and automatically transferred to the HipCheck system, offering real-time feedback on the current extent of resection. This offers the surgeon a more controlled resection, as images can be obtained in different positions periodically throughout the procedure.

We then proceed with our standard cam resection.

Cartilage is removed with an ablation device. A trough is created to make a template for resection using the arthroscopic burr.

We then remove sclerotic bone both proximally and distally with a gradual taper from the template trough.

Here we demonstrate the distal taper.

Here we illustrate additional proximal tapering.

Here we refine the resection and ensure sclerotic bone is removed.

Finally, the dynamic evaluation is repeated to assess the adequacy of resection.

The dynamic assessment is performed arthroscopically and fluoroscopically. The resection will be re-evaluated using the software in all 6 of the previously registered positions. This allows the surgeon to ensure that the same images and positions used to calculate alpha angles prior to resection are again analyzed postresection, offering the surgeon a direct "apples-to-apples" comparison, ensuring the operative plan was maintained.

The next slides demonstrate the postresection fluoroscopic images using the software along with arthroscopic images in those locations. We can see that in each position our alpha angle of resection is in green, demonstrating appropriate resection.

Here are comparisons from pre- to postresection, with pre-resection images demonstrated on the left and postresection images demonstrated on the right. Each image shows us improvement in alpha angle and appropriate resection. On top of the quantitative measurements of the alpha angle, the HipCheck system offers enhanced visualization of the head-neck junction by providing an adjustable resection curve. As demonstrated in the left-hand images prior to resection, a yellow resection curve is seen, indicating further resection needs to be performed in this hip position. As the surgeon resects more of the cam deformity, the resection curve becomes less prominent and turns green, indicating adequate bony resection. Particularly for surgeons with less experience, the combination of these quantitative and visual measures facilitates accurate resection early on in practice.

Again, the key steps are adequate exposure which we perform using a T-type capsulotomy with traction sutures, registering the software pre-resection with 6 key fluoroscopic images, beginning the cam resection with a trough and then tapering to the templated resection area, and then re-evaluating the resection arthroscopically and fluoroscopically in the 6 positions using the software.

Our standard postoperative protocol is demonstrated here.[7]

Complications involving the software could be related to difficulty registering, inaccurate measurements, or malfunction. Therefore, the surgeon should feel adept to perform the surgery independently without relying on the software.[4] Additional complications associated with standard hip arthroscopy, labral repair, and osteochondroplasty are listed below.[1,2,3,8,10]

One study[6] performed by the senior author evaluated the efficacy of the computer vision interface system. The system evaluated the alpha angle fluoroscopically, and patients who had computer-guided resection were compared with those who had standard resection. With 51 patients in each group, there was successful reduction in alpha angle and no differences between groups in degree of resection. Various computer views had good correlations with clinical radiographs, including the 11:45 view with the anteroposterior view, the 12:30 view with the 90° Dunn lateral, and the 1:45 view with the false profile view. In conclusion, the computer navigation system can guide successful cam resection and can correlate to clinical radiographs.[6]

Here are our references.

And we thank you for watching our video.

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