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Operative Techniques in
Orthopaedics

Operative Setup Up and Positioning

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Initially a limited diagnostic adjunct, hip arthroscopy is now a safe and effective tool that can be used to treat a number of intra-articular and extra-articular hip pathologies. Multiple factors influence the outcomes of these procedures, including etiology and presence of concomitant degenerative joint disease. While these factors are often beyond the control of the operating surgeon, a routine and streamlined operating room setup can help optimize surgical efficiency and familiarize the operative team with the surgical procedure. Moreover, understanding the ways in which patients can be positioned and the ways hip distraction can be obtained—as well as the risks therein—can help avoid pitfalls in a procedure with an inherently steep learning curve. By controlling operative setup and patient positioning, surgeons can limit variability, more quickly expand the array of procedures offered and ultimately improve patient outcomes.
Oper Tech Orthop 29:100740

KEYWORDS hip, arthroscopy, femoroacetabular, positioning, traction, setup

Introduction

Initially described by Burman in 1931, hip arthroscopy has evolved from a diagnostic adjunct into an effective tool in the treatment of many hip disorders.[1,2] Although a number of pathologies can manifest in the hip, labral tears and femoroacetabular impingement (FAI) are the most common pathologies surgically managed with hip arthroscopy.[3] The pathogenesis of FAI is elaborated on in its respective chapter. Briefly, FAI describes a pathologic articulation between the femoral head-neck junction and the acetabular rim. FAI can be classified under 3 subcategories: pincer-type, CAM-type, and, most commonly, a mixed-type deformity. Careful preoperative planning and fluoroscopic guidance are paramount in identifying the areas of acetabular and femoral deformity and proposed osteoplasty.

Nonoperative management remains the first-line treatment for many hip disorders, however, hip arthroscopy has proven to be a reliable and effective treatment modality for recalcitrant pain.[4,5] Nonoperative success has been shown to hinge on the etiology of hip pain and preoperative demands.[5] The clinical outcomes between the arthroscopic and open treatment of FAI are similar.[6] Even in the professional athlete, hip arthroscopy has demonstrated successful return to elite levels of play.[7,8]

While pathology and patient risk factors may be uncontrollable variables, the treating surgeon can control certain variables. Careful attention to operative setup and patient positioning can allow the surgeon to improve patient safety and operative outcomes. A consistent and reproducible setup can allow for familiarity of hip arthroscopy amongst team members and optimize operative efficiency.

Operative Setup

General Setup

Operating room setup should remain consistent between cases, organized in a way to facilitate the use of fluoroscopy, lower extremity manipulation and traction, and arthroscopic visualization. Specifically, fluoroscopy, the arthroscopic viewing monitor, and the arthroscopy device units (including fluid systems, radiofrequency ablation, and shavers) should be positioned on the contralateral side of the patient (Fig. 1). The surgical technician, back table, and mayo stand should be positioned on the operative side. Sufficient space should be maintained on the caudal aspect of the patient to allow for intraoperative manipulation of the lower extremities (Fig. 2). The C-arm/fluoroscopy unit should approach the patient from the contralateral side, and image projection should be viewed

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https://doi.org/10.1016/j.oto.2019.100740
1048-6666/

Figure 1 Operating theater setup, demonstrating arthroscopic tower, and arthroscopic device units on the contralateral side of the operative extremity.

without obstruction. By approaching the hip at an angle, the C-arm can move in and out of the operative field when needed (access to the central compartment and during the femoral osteoplasty, and during labral repair, respectively).

Patient Positioning

Once brought into the operating room and transferred onto the operating table, general anesthesia should be induced,

Figure 2 Operative setup demonstrating sufficient space caudal to the patient, allowing for intraoperative lower extremity manipulation.

with muscular paralysis necessary to elicit sufficient hip distraction. Maintenance of mean arterial pressure ≤ 100 mm Hg and use of epinephrine (1 mg epi per 3 liter bag (0.33 mg/liter)) in the irrigation solution will minimize bleeding and optimize arthroscopic visualization. Regional anesthesia can be used as an adjunct preoperatively or postoperatively for pain control.

The patient can be positioned supine or lateral decubitus with the operative extremity up.[9,10] Regardless of position and table employed, sufficient distraction across the hip joint is of primary concern. Sufficient distraction will allow for the safe introduction of instrumentation in an atraumatic manner. The distracting vector is caudal and lateral, in line with the femoral neck rather than the long axis of the body. This vector is achieved by lateral post position and the caudal traction placed on the extremity. The perineal post should be well padded to minimize the risk of pudendal nerve injury.

Hip distraction can also be obtained without the use of a perineal post.[11,12] Mei-Dan et al examined a prospective cohort of 1000 hips and obtained sufficient hip distraction via the use of Trendelenburg and the patient's body weight as a means of counter traction without the need for a perineal post.[12] Compression-related perineal nerve injuries were eliminated in their series.[12] The supine position has some limitations. In obese patients body habitus may obstruct positioning. Access to the joint may be limited by a large anterolateral osteophyte and posterior hip joint access is limited as compared to lateral positioning.[10,13-15]

In the supine position, both feet are placed in well-padded boots and secured to leg holders through which traction and countertraction are applied (Fig. 3). A lateralized perineal post is attached to the table and the patient is moved caudally until the perineum abuts the post. The genitalia should be checked to avoid compression against the post. Gentle countertraction is applied to the contralateral extremity (10-20 lbs) to stabilize the patient on the table. The ipsilateral arm is then padded and draped across the torso. Care is taken to prevent flexion beyond 90° at the elbow to avoid neurovascular compression.

In the lateral decubitus position, anesthesia is induced, the operative foot is placed in a well-padded foot holder and the patient rolled into an operative extremity up position. An axillary roll is placed low out of the axilla to limit iatrogenic brachial plexopathy and compressive hip positioners are used to secure the pelvis. A raised post provides a lateralizing force against the proximal femur without compression of the perineum. Genitalia are checked to avoid compression by the post. The upper extremities are kept below 90° of flexion to prevent ischemia.

Few studies have directly compared supine vs lateral positioning, but a recent systematic review compared outcomes and complications in both positions. The authors found an increased risk of neuropraxic injury, labral penetration, and heterotopic ossification in the supine position compared to an increased risk of missed loose bodies and fluid extravasation in the lateral decubitus position.[16] Revision rates were similar regardless of position.[16] Once positioned, the operative hip is then placed in slight flexion to relax the Y ligament

Figure 3 Lower extremities placed in padded boots and leg holders.

of Bigelow and facilitate distraction. Flexion beyond 20° can endanger the femoral or sciatic nerve.[17]

Fluoroscopy

Preoperative fluoroscopic imaging should be obtained to confirm the surgical plan and guide intraoperative resection. A recent survey of 127 high-volume hip arthroscopists confirmed that all surgeons use intraoperative fluoroscopy at a minimum in order to safely access the central compartment of the hip.[18] Ten standardized radiographic views can be used to for full visualization of the head-neck junction, cam deformity and area for proposed resection.[19] The modified Dunn view consistently visualizes the anterosuperior aspect of the femoral head-neck junction where most cam deformities occur.[19] A dynamic fluoroscopic exam is undertaken to assess the extent of impingement between the femoral head-neck junction and acetabulum. The dynamic evaluation should be repeated after resection of the CAM deformity to ensure resolution of impingement. Radiation exposure from fluoroscopy has been investigated during hip arthroscopy to ensure safety.[20,21] In a series of 210 arthroscopic cases performed by a single surgeon, radiation levels were measured and compared to the dose limit recommendations established by the International Commission on Radiological Protection.[20] While surgeon experience clearly influences radiation exposure, the study found the dose to be well below the International Commission on Radiological Protection thresholds suggesting that fluoroscopic guidance is safe even during the early learning curve.[20] Canham et al determined that radiation exposure to patients and OR personnel is affected primarily by patient BMI.[21]

Hip joint distraction

Following complete fluoroscopic assessment, distractibility of the hip joint is confirmed. General anesthesia with complete muscle paralysis should be confirmed prior to the application of traction. Adequate distraction across the hip joint allows for atraumatic instrumentation during hip arthroscopy. Meticulous patient positioning and careful attention to traction force and time are essential to avoid complications. While variability in ultimate distraction force occurs due to patient specific factors (BMI, extent of arthritis, ligamentous laxity, and muscle tone/paralysis), the vacuum forces across the femoral head and acetabular labrum are typically around 130 N 200 N.[22] Once this initial vacuum seal is broken, the force necessary for hip distraction is considerably less.[22] Traction should first be applied grossly to prevent the surgeon from exceeding the limitations of fine traction available. Careful attention should be given to assure the feet do not loosen or slide from the holders during traction maneuvers.

Appropriate distraction is confirmed and monitored via fluoroscopy. A crescent sign, or widened joint space, should be appreciable in the appropriately distracted joint (Fig. 4). In the event that the surgeon is unable to easily distract the hip joint, distraction can be obtained by either continuing to apply gentle traction (ie, through ligamentous creep) or via air arthrogram. For the latter, the hip is prepped in sterile fashion and the joint approached with a spinal needle under fluoroscopic guidance. Once the stylet of the spinal needle is removed, the suction seal of the hip will be broken and the joint should distend with air. Once the ability to distract is confirmed, traction is released and the patient is formally prepped and draped. Traction is reapplied after sterile prep to limit total traction time.

A cadaveric study examining 8 hips found a 1.59-2.25 fold increase in distraction across the hip when traction was coupled with air distension.[22] The authors contend that the high traction forces typically required to break the suction seal may be mitigated with initial air distension possibly reducing risk of soft tissue and neurologic injuries.[22] Pretraction air arthrography may also reduce pain associated with distraction and the surgical procedure. A cohort study examined 35 patients who underwent pretraction hip venting via air arthrography compared to a group of similar patients who did not. The study group was found to have significantly lower numeric pain rating scale scores and lower total opioid requirements in the postanesthesia care unit.[23]

Complications

Complications after hip arthroscopy are often positioning related. Knowledge of potential complications is necessary to avoid them. Hypothermia is an often overlooked risk during hip arthroscopy, but the incidence can approach 3% of cases.[24] Multiple patient and surgical factors play a role in

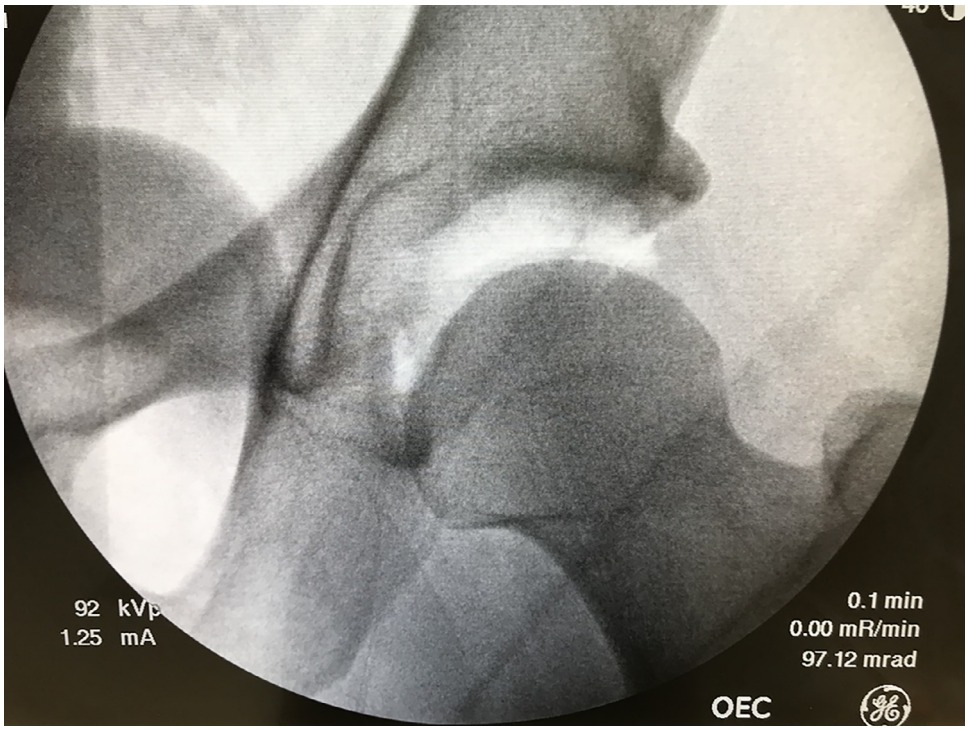

Figure 4 Fluoroscopic image demonstrating hip distraction.

the development of intraoperative hypothermia including; low body mass index, low blood pressure, and prolonged surgical times.[24] To mitigate these factors, normothermia can be facilitated by using a warming blanket or warmed saline irrigation throughout the procedure.[24,25]

Hip arthroscopy risks nerve injury including risk to the pudendal, lateral femoral cutaneous, sciatic, and superficial peroneal nerves.[26] With arthroscopic portals anterior to the greater trochanter, the lateral femoral cutaneous and femoral nerves are at risk with deep incisions. Byrd emphasized only the skin should be incised with a scalpel, followed by deeper penetration with blunt instruments to reduce risk of nerve transection.[27] Beyond transection, nerve injury remains a significant concern during hip arthroscopy. In a recent series of 52 consecutive patients, 46% of patients reported symptoms of nerve dysfunction during the first postoperative week.[28] While the majority of symptoms resolved by one year postoperatively, awareness of these possible complications is necessary to guide preoperative discussion with patients.

Perineal posting can lead to pudendal nerve compressive injury. In general, traction time less than 2 hours significantly reduces risk of pressure related nerve injury.[29] Pressure is also reduced with increased post padding (greater than 9 cm).[29] Salas and O'Donnell stressed that traction time should be carefully monitored in the lateral decubitus as well.[31] In 200 hip arthroscopies performed in the lateral position, there was an incidence of 2% of nerve injuries, all affecting the perineal sensation in men, all of which resolved by 3 months.[31] They noted that traction times limited to 32 minutes had fewer injuries, and conclude that traction time up to 73 minutes can safely be employed with recovery of neurologic deficit by 3 months.[31] Traction and joint distraction is necessary to assess and address pathology in the central compartment but care should be taken to limit traction time and allow normalization of tissue pressures. Traction can usually be released during peripheral compartment work and reapplied if further central compartment assessment or work is required.

Traction injuries to the femoral and sciatic nerve are rare but serious sources of postoperative disability and dysfunction. For traction injuries, the maximum force and not the time in traction has been cited as primary are of concern. Telleria et al prospectively investigated the somatosensory (SSEP) and transcranial evoked potentials (tcMEP) of 76 patients undergoing hip arthroscopy in the lateral decubitus position and found that the maximal weight of traction was significantly greater in those who sustained sciatic nerve dysfunction (a 50% reduction in SSEP or tcMEP amplitude or 10% increase in SSEP latency).[30] Specifically, the odds of injury (ie, clinical loss of sensory or motor function) increased 4% with every 1lb increase in traction.[30] The authors determined that the time in traction did not change the odds of a traction related nerve injury.[30]

Successful patient outcomes following hip arthroscopy are predicated on a number of factors, some inherent to the patient or pathology and others within the control of the surgeon. Operating theater setup and patient positioning is a clearly controllable surgeon factor. A consistent and reproducible operating room setup will improve operative efficiency, familiarize the operative team with the procedure and decrease total traction and operative time. In turn, meticulous attention to patient positioning will reduce intraoperative challenges and maximize patient safety. The learning curve of hip arthroscopy is steep and challenging. A complete appreciation and understanding of safe OR setup and patient

positioning and the risks therein are essential to optimizing patient outcomes while minimizing risk.

Conflict of Interest Statement

Anant Dixit, MD: No conflict. John P. Salvo: J.P.S. is a paid consultant for Stryker.

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