Fluoroscopy in Hip Arthroscopy

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ABSTRACT

Introduction: Fluoroscopy is an important tool to facilitate hip arthroscopy, from initial joint access to real time assessment of bony decompression. Surgeons typically underestimate the amount of radiation exposure during fluoroscopic-guided hip arthroscopy.
Methods and materials: 100 patients were enrolled. The two senior surgeons both averaging greater than 150 hip arthroscopic procedures per year. Fluoroscopic time was obtained from the fluoroscope as the measurement of radiation exposure.
Study Design: Level 4
Results: The mean total fluoroscopy time was 57.19 ±11.3 seconds/hip arthroscopy. The mean of fluoroscopic image shots in each procedure was 66.1± 12.0.
Conclusion: Understanding the amount of fluoroscopy used in hip arthroscopy will allow hip arthroscopists to better limit the amount of radiation exposure to themselves, the OR staff and to patients. Education about the risks of radiation is an important step in training hip arthroscopists.

Key Words: femoroacetabular impingement, labral repair, radiation

INTRODUCTION

Hip pathology in young adults with certain conditions is treated with more reproducible results due to the significant improvements in arthroscopy of the hip. Femoroacetabular impingement (FAI) occurs when there is abnormal abutment between the femur and the acetabulum (Parvizi, 2007). Two types of FAI exist, but the majority of patients have a mixed type with features of both. The pincer-type is described as overgrowth of the acetabular rim while the cam-type presents with the triad of abnormally large alpha angles, anterosuperior cartilage lesions, and labral tears due to a nonspherical shape of the femoral head at the head-neck junction and reduced depth of the acetabulum (Pfirrmann, 2006). Fluoroscopy can be a valuable tool in the intra-operative correction of FAI.

Hip arthroscopy, when performed in supine, frequently requires fluoroscopic assistance during portal placement, FAI evaluation and correction (Larson, 2009). Fluoroscopy is useful in determining the bony anatomy, e.g. the AP view for both pincer and cam and the lateral view for cam visualization. It can also be used to perform a dynamic assessment of hip impingement. Lastly it is useful during the surgery for determining the amount of traction for appropriate hip distraction, antero-lateral portal and burr placement, cam and pincer correction, and placement of anchors as needed.

In the placement of portals, fluoroscopy helps to avoid iatrogenic injury to the labrum or the cartilage surfaces. The first portal in the hip arthroscopy is typically the anterolateral portal, which should be established under fluoroscopic guidance to minimize the risk of trauma (Byrd, 2000).

The goal of treatment of the cam lesion in FAI is to recreate the normal head-neck junction offset. This is facilitated with the use of fluoroscopy. Prior to incision, 180 degree fluoroscopic assessment of the femoral head-neck junction can play an important role in better understanding the cam lesion in a dynamic fashion. Fluoroscopy also assists to localize the optimal position of the cam decompression. The medial extent of decompression starts at the inferior-medial synovial fold and should be followed by fluoroscopy up to the superior head-neck junction. While the cam type femoral osteoplasty is performed, periodic fluoroscopy checks can be invaluable to ensure both restoration of sphericity to the femoral head-neck junction as well as adequate decompression of the cam lesion.

Arthroscopic acetabular osteoplasty can be technically challenging to perform with precision. Intra-operative assessment of the extent of acetabular rim resection is very important. Over-resection can lead to hip microinstability, iatrogenic hip subluxation and dislocation (Matsuda, 2009; Philippon, 2010a; Philippon, 2010b). Under-resection may leave residual impingement. Fluoroscopy can be used to define the margins of the pincer lesion to clearly visualize the relationship between the anterior and posterior walls of the acetabulum. After resection of the prominent rim in pincer-type impingement, fluoroscopy can verify the absence of the crossover sign—provided the angle of the fluoroscope is the same as the angle of the pre-operative AP pelvis radiograph.

Labral tears are the most common pathologic finding identified during hip arthroscopy in athletes (Kelly, 2005; McCarthy, 2001). Repair of the labrum can preserve function of the labrum (Philippon, 2010a). Anchor placement should be positioned to preserve the labral seal and avoid intra-articular penetration. Fluoroscopy can be used to assist anchor placement at the edge of acetabulum as needed.

Fluoroscopy can be a useful adjunct in the treatment of per-trochanteric space disorders as well. As the anatomic landmarks can be somewhat difficult to localize when initially placing the arthroscope into the peri-trochanteric space, fluoroscopy can be a time and trauma saving tool. The arthroscope and the shaver are visualized fluoroscopically heading for the vastus ridge. Landmarks such as the vastus ridge, the gluteus medius tendon, the trochanteric bursa and the vastus lateralis origin are then visualized and treatment of pathology is this region can commence. If treatment of gluteus medius tendon pathology is warranted, fluoroscopy can aid in anchor placement.

One of the pitfalls associated with using fluoroscopy is the lack of risk assessment for individual surgeries. There are many published studies detailing exposure risks for a variety of cardiologic, urologic and orthopedic surgeries; however, none describe those associated with hip arthroscopy.

The purposes of this study are to describe how fluoroscopy is used during different steps of hip arthroscopy and to quantify the radiation exposure during the procedure. Knowledge of these two concepts will bring attention to the potential risks of fluoroscopy to all hip arthroscopic surgeons.

METHODS AND MATERIALS

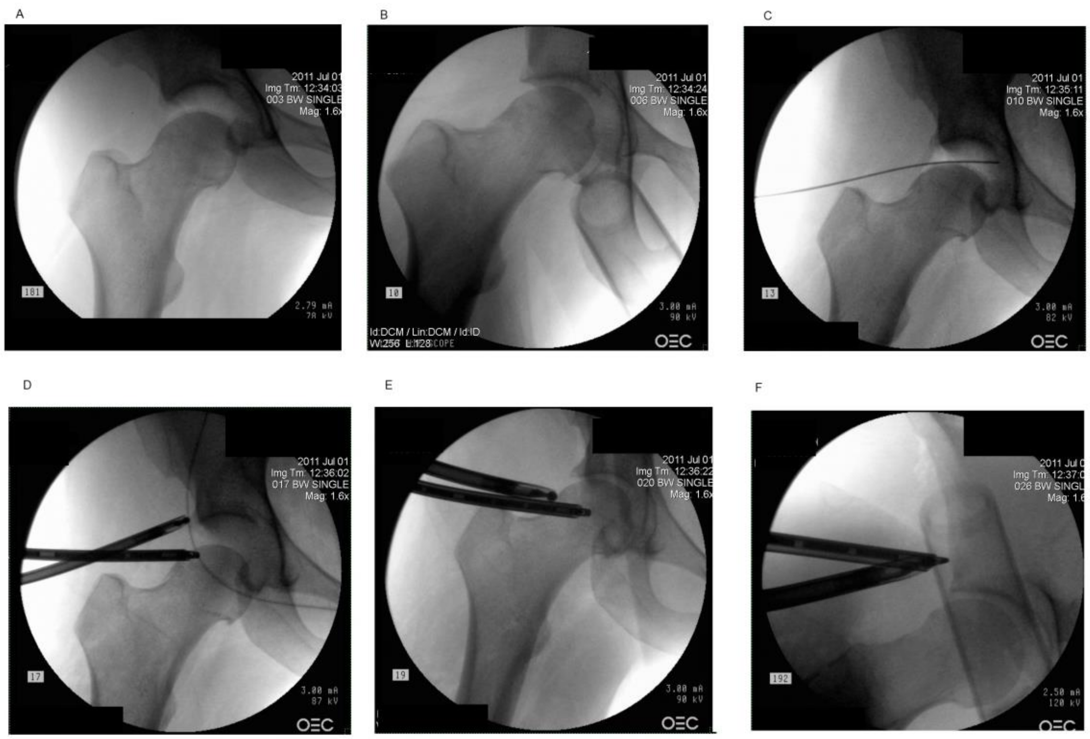
Subjects

The medical records were reviewed of 100 patients who underwent hip arthroscopy for labral injuries and FAI between January 2010 and January 2011 after IRB approval was granted. The same fluoroscopy unit was used for all cases (GE OEC 9600) were included in this study. Fluoroscopy time, fluoroscopy setting and the number of images during surgery were reviewed from the fluoroscope and were reported in seconds, kV and number of images, respectively.

Surgery

Surgery was performed by 2 experienced hip arthroscopists, both with over 3 years of experience and greater than 150 cases per year. Under anesthesia the range of motion of both hips was compared. Counter-traction was applied to the non-operative extremity and kept in 70° of abduction, neutral rotation and 5-10° of flexion. The operating hip was kept in 10° of flexion, maximal internal rotation and 0° of abduction. At this point the bony anatomy of the hip joint was checked using C-arm intensifier. The cam lesion and pincer lesion were evaluated in extension and internal rotation (Botwin, 2001; International Commission on Radiological Protection, 2001). Mobility of the fluoroscope and the operative leg helps to get multiple views of the hip pre-,intra- and post-operatively. (Figure 1)

Figure 1: Fluoroscopic views during hip arthroscopy.(A-F)



Photos are as follows: A= AP view illustration traction
B= 60 degree oblique view
C= placement of needle and air arthrogram
D= pincer resection
E= cam resection
F= ccorrection

This is especially helpful for the evaluation of the cam lesion. To facilitate pincer evaluation, the fluoroscope was arranged in AP view of the hip. This AP view aids in assessment of the treatment of the crossover sign and/or coxa profunda. For traction, a regular fracture table was used by one of the authors, while an OR table traction attachment device was used by the other author. Fluoroscopy was used to assess adequate distraction of the hip joint. Dual-portal hip arthroscopic surgery was performed in supine position. The anterolateral portal was established under fluoroscopic guidance and the anterior portal was placed under arthroscopic guidance. Intra-operative fluoroscopic imaging helps to identify the exact position of the burr during correction of cam and pincer lesions. Removal of the prominent wall for pincer lesion was mostly performed under traction in extension position. Correction of cam lesion was performed at varying angles between 0 and 90° flexion of the hip joint.

Dynamic assessment of impingement was performed under the fluoroscopy guidance as needed (in flexion, internal and external rotation, abduction and adduction). Intermittent fluoroscopic imaging was used to verify that the correction was adequate.

RESULTS

Of the patients reviewed, forty-one were male and fifty- nine were female. The average age of patients' was 33.86 SD ± 14.8 years (range of 14-61 years). The dose of radiation exposure was measured by total fluoroscopic time as recommended by FDA and ICRP (Byrd, 2000; Fishman, 2002). The mean total fluoroscopy time was 57.19 ±11.3 seconds/hip arthroscopy. The mean fluoroscopy setting during hip arthroscopy was 107.19 ± 23.3 kV. On average 66.1± 12.0 fluoroscopic shots were used in each procedure.

DISCUSSION

Using fluoroscopic imaging as an adjunct to orthopedic surgeries has dramatically increased in recent years. This modality has the advantage of providing guidance for orthopedic surgeons while exposing patients to radiation for a relatively short time. However, cumulative exposure to radiation is not without risks, to both the patient and the OR surgical staff (Mahesh, 2001; Mroz, 2008). Overexposure to radiation has been shown to cause cancer, burns, and teratogenic effects. The parameters which influence radiation exposure are time, distance, and shielding (International Commission on Radiological Protection, 2001; Mahesh, 2001). As a general rule of thumb, the time of exposure should be minimized while distance and shielding from radiation should be maximized. Risks can be minimized with proper education and if appropriate safety measures are followed. Radiographic techniques may also be altered to decrease total radiation time, as is done with pulsed fluoroscopy (Mahesh, 2001; US Food and Drug Administration, 1995).

An additional concern for the physician is beam scattering off of the patient and needs to be factored into their radiation safety protocol. The higher the patient dose the more scattering which can affect the entire staff present at the time of procedure. Recent studies have shown that during a fluoroscopy guided epidural injection with the physician positioned 1 m away from the patient; the beam scatter was measured to be 0.3 mrem (Fishman, 2002). Typically these procedures are rapid, with a mean fluoroscopic time of 15.16 sec (Botwin, 2001). The two best safety measures, positioning of staff away from beam and the patient and the use of protective equipment, often make it difficult and cumbersome to perform technically demanding procedures like hip arthroscopy. For this reason, it is critical to monitor exposure times and levels to maintain staff safety.

Due to improvements in our understanding of non-arthritic and pre-arthritic hip conditions coupled with advancements in arthroscopic instrumentation, hip arthroscopy is being performed at an increasing rate. Fluoroscopy is an extremely valuable tool in the arthroscopic treatment of hip pathology. The issue of radiation exposure is underestimated by surgeons who are not well trained in the association of ionizing radiation to various forms of cancer and risk of cataract formation (National Council on Radiation Protection and Measurements, 2006). The surgeons are usually protected by the lead apron and the thyroid shield, so the radiation exposure is less than the minimum reportable dose. However, we have to consider the unprotected areas, such as the eyes and the hands which are exposed during FAI correction. The National Council on

Radiation Protection and Measurements in 1993 suggested an occupational exposure limit (National Council on Radiation Protection and Measurement, 2006). The annual permissible radiation doses as determined by the NCRP range from 5 rem for whole body, 15 rems for the lens of the eye and 50 rems for thyroid, extremities and gonads (National Council on Radiation Protection and Measurement, 2006). The exposure dose to the surgeon depends on the exposure time. In our study the fluoroscopy time was 57.19 ± 11.93 seconds per procedure. This is less than the reportable time for kyphoplasty (7.2 ± 2.6 min/procedure), percutaneous coronary intervention (10.3 ±7.4 min/procedure) or coronary angiography (4.2 ± 3.5 min/procedure). Despite our reported times, it is of note to mention that use of fluoroscopy and total fluoroscopic time is highly variable between surgeons. One must consider the learning curve of hip arthroscopy, a recent study reports characterize experienced surgeons as those performing 50 cases per year (Ochiai, 2011). Therefore in the inexperienced surgeon the time of the procedure and the amount of fluoroscopy used may be increased thereby increasing their exposure particularly in unprotected areas such as eyes and hands. Similarly, differences may exist between machines which would alter exposure levels. Our study adds to the literature by describing the amount and safety of radiation used during hip arthroscopy. Additionally we highlight the importance of instruction in fluoroscopic technique during arthroscopic training programs.

Opportunities for further study include evaluation of exposure to unprotected areas of the body through use of badge dosimeters at the level of eyes and ring dosimeters worn for the hands. Education about the risks of radiation is a crucial step in the training of hip arthroscopy to minimize the amount of radiation and ensure the safety of doctors, patients, nurses and staff.

ACKNOWLEDGEMENTS

No funding was directly provided for this research. Fellowship support (F.A.) was received from Arthrex Financial affiliations include Tenex Health, Smith & Nephew, International Medical Publishing, Travanti Pharma (D.O.) Professional affiliations include President- Virginia orthopedic society (D.O.)

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