Is a hip distractor useful in the arthroscopic treatment of femoroacetabular impingement?

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Summary

Introduction: There is increasing interest in using hip arthroscopy for the treatment of femoroacetabular impingement (FAI). However, the distraction is typically done with a traction table, which can lead to complications. Our working hypothesis was that a hip-specific distractor could be used to perform arthroscopic treatment of FAI without the complications associated with traction.

Material and methods: Twenty-three patients were included in this prospective study with an average follow-up of 21 months (range 12–28 months). The average age was 34 ± 4 years. The technical feasibility, complications, quality of the distraction and early clinical results were evaluated.

Results: None of the arthroscopy procedures had to be converted to an arthrotomy. In all cases, the procedures planned for the central and peripheral compartments were fully executed. One patient (4%) had a grade 1 cartilage iatrogenic injury of the femoral head. The distraction was determined to be effective in all the patients, with an average of 15 mm of distraction achieved (range 12–21 mm). The average Merle d’Aubigne score went from 11 (range 9–18) preoperatively to 16 (range 14–18) postoperatively; the average Harris score went from 76 (range 46–80) to 91 (range 87–100); the average Christensen score went from 64 (range 48–88) to 84 (range 72–100); the average Womac score went from 58 (range 42–96) to 84 (range 74–100). No neurological, infectious or bone complications were recorded.

Discussion: The use of a distractor during hip arthroscopy appears to be a reliable and reproducible technique that allows FAI to be treated. Early results are consistent with those
Introduction

Femoroacetabular impingement (FAI) is one of the most important diagnostic findings to explain hip osteoarthritis in young people. It was first described by Carlioz et al. in 1968 [1] then identified by Ganz et al. [2] following excessive displacement of peri-acetabular osteotomies, a condition defined as "abnormal, repeated contact between the femoral head/neck junction and the acetabular margin leading to injuries to the labrum and cartilage". This pathology is a cause of hip pain and early arthritic changes in young adults, and one of the main causes of "early" hip osteoarthritis according to Beck et al. [3] and Ganz et al. [4]. This abnormal contact is due to a morphological abnormality on the femoral side that results in a "cam" effect and an abnormality on the acetabular side that results in a "pincer" effect, these two conditions can exist in combination. The cause of this abnormality is controversial, genetic theories [5], the magnitude of movements in the hip girdle [6] and a potential relationship with hip dysplasia [7] have all been proposed.

Surgical treatment is conservative. It aims to re-establish the anterosuperior femoroacetabular space while correcting the causal abnormalities. The classic surgical dislocation proposed by Ganz et al. [8] has now been replaced by mini-open [9–11] and arthroscopy procedures. Despite promising clinical results [12–20], the complication rate with arthroscopy ranges from 1 to 9% [21–27]. These complications include neurological complications, aseptic necrosis of the head of the femur, compartment syndrome, fluid extravasion into the abdomen cavity, intra-articular breakage of arthroscopy material, and not being able to perform the procedure [21–27]. Effective distraction is needed to access this joint. This distraction can lead to neurological complications in the sciatic and pudendal nerves and the perineal area (necrosis of the scrotum [22] or the outer labia [28,29]) that can reach 10% [30] and are related to the time and technique used to accomplish the distraction [28,31].

We have been using a hip arthroscopy-specific distractor (DR Medical AG, Solothurn, Switzerland) on patients in lateral decubitus. In theory, this instrumentation produces an effective distraction and eliminates the neurological risks associated with use of a classical traction table and perineal post. Our working hypothesis was that a hip-specific distractor could be used to perform arthroscopic treatment of FAI without the complications associated with traction.

Patients and methods

Population

Twenty-three patients (14 men, nine women) were enrolled in this on-going prospective study. The average age was 34 ± 4 years (range 17 to 54). Inclusion criteria were mechanical pain in the inguinal fold, buttocks or trochanter region that was reproduced during passive mobilization of the hip in flexion and internal rotation, on-going for at least 6 months, failure of conservative treatment (treatment of symptoms, rehabilitation), no osteoarthritis (stage 1 or less in the Tönnis classification [32]), a minimum one year postoperative follow-up and imaging tests that confirm the diagnosis of FAI. These imaging tests included standing straight-on A/P X-rays of the pelvis, AP and lateral X-rays of the hip according to Dunn, a CT arthography and MR arthrography (with intra-articular injection) with radial slices to confirm the anatomical predisposition to impingement and identify the presence and extent of labrum and cartilage lesions.

Distractor

The distractor is a stainless steel device (Fig. 1) weighing 4 kg and that is 530 mm wide and 320 mm deep. A distraction load up to 500 N (50 kg) can be applied and maximum lengthening (x-axis) is 160 mm (A on Fig. 1). Holes are provided to insert the pins into the femoral (B on Fig. 1) and acetabular side (C on Fig. 1). The distractor can freely rotate 360° around its axis and move ± 25° relative to its plane. The rear portion can be rotated up to 70° (D on Fig. 1) relative to the plane of the distractor so that an unobstructed view of the hip is available on the image intensifier. The goal of using this distractor is to access the central compartment; it is removed to access the peripheral compartment.

Surgical technique

With the patient in lateral decubitus and the hip in 20° of flexion, classic perineal and sacrum supports were placed slightly higher than usual to ensure that the hip can be viewed during fluoroscopic verification. After draping and horizontal placement of the image intensifier with the source perpendicular to the table, the surgeon stood behind the patient facing the screen of the image intensifier and the arthroscopy system. The first step was the placement of the distractor (DR invasive distractor, DR Medical AG, Solothurn, Switzerland). Similarly to an external fixator, two threaded pins (5 or 6 mm diameter) were inserted: one in the femoral diaphysis through both cortices at the level of the lesser trochanter, the other in the roof of the acetabulum, 1 cm above the joint line. The distractor was put into place, locked with the pins by screwed guide tubes and applied at the bone surface. Finally, the placement included two other threaded pins that were put into position through guide tubes and modified drill guides, and rein-
forced with threaded sleeves to increase the stiffness of the setup (Fig. 2b). These four pins are single use. The distraction was performed using a worm screw in the axis of the distractor to obtain a 12 mm space, which corresponds to the width of two pins by fluoroscopic verification. The pins and sleeves become progressively bent during the distraction (Fig. 3). Two procedures were used to improve the distraction: a biopsy needle was placed into the joint to cancel out the suction effect and the hip was abducted up to 20°, a position that was maintained by placing sterile rolled drapes between the legs and by having the foot rest on a table post at the appropriate height.

Typical arthroscopy approaches were used: first the anterolateral portal was installed under fluoroscopic guidance, making sure to avoid the femoral head cartilage, and then the posterolateral and anterior portals were installed. A 70° arthroscopy (Karl Storz, Tuttingen, Germany) was used to visualize peripheral and central compartments of the hip joint. A capsulotomy was performed systematically from 10 o’clock to 4 o’clock (for a right hip) using a capsulotomy-specific blade, to allow instruments to move freely. After assessing the extent of labrum and cartilage injuries, procedures were first performed in the central compartment and included procedures on the labrum, cartilage and/or acetabulum margin, and then followed by bone procedures. The traction was then removed and the peripheral compartment procedures performed: an anterosuperior capsulotomy followed by a resection of the anterosuperior cam. The joint was then tested with flexion/internal rotation movements to ensure that there was no impingement. The test was successful when internal rotation with hip flexion attained more than 20°, without contact between the neck and labrum seen through arthroscopy.

Postoperatively, protected weight bearing was allowed based on pain. Rehabilitation started immediately with passive joint motion to avoid any joint constriction during healing.

Analysis methods

The technical feasibility, intra-articular iatrogenic complications, quality of the distraction and early clinical results were evaluated. Technical feasibility was evaluated as a function of the number of procedures completed without conversion to a classic arthrotomy, along with the number of procedures that were performed as planned (access to the labrum for debridement or suturing, access to the femoral neck for an osteoplasty). The quality of the distraction was evaluated. The distraction was considered as effective if the joint space was at least 12 mm, which corresponds to the diameter of two distractor acetabular pins visible by fluoroscopy. Intra-articular iatrogenic complications were evaluated based on the ability to introduce instruments without damaging the acetabulum or femoral head cartilage (cartilage injury according to the Outerbridge classification [33]) or injuring the labrum. Evaluations of pre- and postoperative function at 1, 3, 6 and 12 months and the follow-up were done using the Postel Merle d’Aubigné (PMA) [34], Harris [35], Christensen [36] and Womac [37] scores. The total operative time, time to implant the distractor and duration of distraction were recorded, along with any potential complications related to the distraction (neurological, infection, pain, ossification).
Results

None of the arthroscopy procedures had to be converted to an arthrotomy. In all cases, access to the labrum (central compartment) and the femoral neck (peripheral compartment) for an osteoplasty was sufficient. The distraction was determined to be effective in all the patients, with an average of 15 mm of distraction achieved (range 12—21 mm).

One patient (4%) had a grade 1 iatrogenic injury to the femoral head cartilage, no iatrogenic injuries to the labrum or acetabulum cartilage were noted. The average operative time was 146 min (range 90—260 min) and became shorter after the learning curve (Fig. 4a). The average implantation time for the distractor was 18 min (range 12—24 min) and was unchanged with the learning curve (Fig. 4b). The average duration of the distraction was 72 min (range 25—180 min) and became shorter after the learning curve (Fig. 4c). The average PMA score went from 11 (range 9—18) preoperatively to 16 (range 14—18) postoperatively; the average Harris score went from 76 (range 46—80) to 91 (range 87—100); the average Christensen score went from 64 (range 48—88) to 84 (range 72—100); the average Womac score went from 58 (range 42—96) to 84 (range 74—100). No neurological, infectious or bone complications were recorded.

Discussion

Surgical treatment for FAI aims to correct the predisposing anatomic abnormalities on the acetabular and/or femoral

Figure 3  Intraoperative progress of the distraction as seen on the image intensifier. A. The pins are implanted, without traction being applied. B. The traction is applied, without abduction or joint aspiration.

Figure 4  Change in operative time over time. a: total operative time; b: time for distractor insertion; c: average distraction time.
side, and treat the resulting problems in the labrum and/or cartilage. Treatment of FAI by arthroscopy is an alternative to classical surgical dislocation [8,38,39] and mini-open approaches [9,11,40] with comparable short-term results and faster functional recovery [41].

Our results raise several discussion points. A larger series, ideally prospective and randomized, would be required to confirm the advantage of this distraction system over typical approaches. However, the working hypothesis was that there would be no complications related to using a distractor to perform traction, independent of the duration of traction and surgeon experience. The cost of this system must be taken into consideration based on procedure volume, as would be required for the purchase of a traction table, but with the additional cost of disposable materials (four, single-use pins). The operative time is on average 18 min longer, which corresponds to the time needed to implant the distractor. However, the time to position the patient is probably shorter, as it is not necessary to apply axial traction with the traction table. The use of 5 or 6 mm diameter pins in the femur and acetabulum seems relatively invasive. Based on our experience, the rehabilitation protocol, including return to weight bearing, was not changed and use of these pins did not result in any complications.

The occurrence of complications related to distraction is difficult to quantify. Only a few published papers have reported on complications following hip arthroscopy. Glick et al. [42] reported eight cases (3.1%) of neuropraxia (four each for the pudendal and sciatic nerves) that resolved spontaneously. This is consistent with Byrd’s report [23] of two cases of transient pudendal nerve neuropraxia in a series of 38 patients (5.2%). Villar [43] reported a case of femoral nerve paralysis that resolved completely within 6 h postsurgery. Byrd [30] also reported a 10% rate of pudendal nerve affection, which resolved within one week, in a series of 20 arthroscopy cases. These complications are directly related to the technique, duration and forces applied during distraction. Souza et al. [28] reported a 6.1% complication rate (12

Figure 5  Arthroscopy view (TF: femoral head, L: labrum). a: central compartment: cartilage flap (1); b: peripheral compartment: femoral cam (2) and anterior synovial fold (3).

Figure 6  Verification with the image amplifier before (A) and after (B) femoral neck osteoplasty.
of 197 cases), of which more than half (57%) were traction-related. In our series, no neurological, vascular or perineal complications were observed. However, comparisons to the published literature must be made with care as most of the series with a high complication rate had a small sample size or were done before newer pubic posts were available.

Similarly, little information exists on the maximum duration of traction or maximum traction force to abide by to avoid complications; most of the available information is from trauma cases [44]. Brumback et al. [45] evaluated the complications believed to be the result of high traction table forces in a series of 106 femur fractures that were treated by nailing. Ten patients had pudendal nerve paralysis (9.4%): nine had sensory changes only and one complained of erectile dysfunction. The symptoms had resolved in three months in all the patients, except for one male patient who complained of dysesthesia six months after the surgery. The patients who did not develop paralysis had an average distraction time of 2.6 h (range 1.4 to 5.2 h) while those who did experience paralysis had an average of 2.8 h (range 2.0 to 4.3 h) (P = 0.15). The magnitude of the traction force was 34.9 kg/h in the patients who did not have a neurological disorder and 73.3 kg/h in those who did (P < 0.03). As advocates of hip arthroscopy in lateral decubitus on a traction table, Glick et al. [31] reported eight cases of neuropraxia in a retrospective series of 58 arthroscopy procedures (13%); four were sciatic injuries that resolved and the other four involved the pudendal nerve, with three being recovered in less than eight weeks. The authors recommended that the traction time be less than one hour and the force under 60 pounds (27.2 kg) to avoid these complications. It has also been reported that injuries to the pudendal nerve were related to direct compression of the nerve branch on the perineal post, while sciatic injuries were more likely related to the amount of traction itself. One can infer that to obtain a 10 mm distraction of the hip joint by applying distraction at the foot, the additional lengthening of the ankle and knee leads to an overall lengthening of the lower limb that could potentially be dangerous to the sciatic nerve. Distraction techniques on a traction table without the perineal post or with a different size or position have recently been developed that seem to reduce the neurologic risk [18, 46–49]. In our series, the average traction time was 72 min, with many patients receiving more than 1 h of traction. One patient had an operative time of 260 min (180 min of traction). This was the first case in our series, early-on in our learning curve, which presented with an isolated cam-effect impingement and a degenerative labrum injury. The procedure was completed without any complications related to the traction or operative time.

In our series, all of the arthroscopy procedures were performed without changing the central and peripheral compartments procedures that were planned before the surgery (Figs. 5 and 6). Griffin and Villar [50] reported that in 30 of 640 cases (4.7%) the procedure could not be completed because of problems related to traction time or traction quality (intra-articular visualization). Clarke et al. [25] reported that in a series of 194 cases, access was difficult in 18% of the cases and impossible in 2.8% of the cases. The average operative time was 146 min (range 90–260 min). The first cases had an operative time around 3 h, with about 2 h of distraction but then the operative time became shorter during the learning curve. The complication rate is mainly related to the learning curve. Cabrita et al. [51] reported a complication rate of 16% on a series of 60 consecutive arthroscopy procedures, most of which occurred in the first 25 cases. There were no complications in our series, including during our first operative cases, despite a lengthy distraction time. It is possible that the incidence of certain types of complications is not reduced with experience. Souza et al. [28] performed a retrospective analysis of 194 cases over nearly 10 years. There were 12 complications (6.1%) in this series. Five were neurologic (2.6%), four were musculoskeletal (2%) and three were vascular or ischemic (1.5%). Two were classified as major complications (1%), eight were moderate (4.1%) and two were minor (1%). The incidence of complications did not change over time or with the number of cases performed, but different types of complications occurred during the learning curve. Their conclusion was that the nature of complications changed with experience, but not the frequency.

The rate of iatrogenic cartilage or labrum injuries during hip arthroscopy is not well known and is probably underestimated [25]. In a prospective series of 73 hip arthroscopy cases, Lo et al. [52] reported that 12 of the 73 patients (16.4%) had an iatrogenic cartilage injury, surprisingly without influencing the results. The quality of the distraction, verified by fluoroscopy, allows for easier movement of instruments inside the joint, while reducing the risk of iatrogenic injuries. A minimum of 7 to 10 mm of distraction is needed to perform an arthroscopy for FAI without risk [53, 54], although less distraction may be sufficient to perform a biopsy or remove a foreign body. In our series, all of our patients had a distraction of more than 10 mm, we hypothesize that the quality of the distraction provided by this system is partly responsible. No other complications were observed. The distractor did not lead to specific complications, which is consistent with the results of a recent series using this device in 32 of 38 hip cases (the six other cases were treated with a standard traction table) [55].

In summary, hip arthroscopy with a distractor seems to be a reliable and reproducible technique that is free of complications, allows FAI to be treated and leads to early results that are consistent with the published literature [17, 20, 56, 57]. With the on-going progress being made in arthroscopic surgery for the repair of labrum and cartilage, procedures that are surgically time consuming; this distractor approach would allow these new procedures to be done without additional complication and fear of the inevitable learning curve.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


