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Open Surgical Treatment for Femoroacetabular Impingement in Patients over Thirty Years: Two Years Follow-up Results

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Purpose: We report short term results of open surgical treatment for symptomatic femoroacetabular impingement (FAI) in patients over the age of 30 years.

Materials and Methods: Between May 2011 and June 2012, thirteen FAI hips (11 patients) with hip pain persisting longer than 6 months were treated by either surgical hip dislocation (SHD) or anterior mini-open. They were followed up for longer than 2 years. The 11 patients included 7 females and 4 males with a mean age of 45 (range, 33-60) years. They were clinically evaluated for modified Harris hip score (MHHS) and University of California at Los Angeles (UCLA) activity level. Their lateral center-edge angle, acetabular index, and alpha angle were measured and compared.

Results: Acetabuloplasties were performed for seven cases. Femoral osteochondroplasty was performed for all thirteen cases. At minimum follow-up of two year (range, 24-29 months), all patients had substantial relief in preoperative pain with improvement in range of motion. The median MHHS was significantly (P<0.05) improved from 61 points preoperatively to 87 points at the last follow-up. The median UCLA activity level was 7 (range, 5-8) at last follow-up. Radiological indices improved. Two cases showed mild residual pain attributable to adhesion between capsule and reshaped femoral head-neck area.

Conclusion: Open surgical treatment of FAI was a reliable and effective treatment method in symptomatic FAIs for patients over the age of 30 years without advanced arthritic change of hip joint at short term follow-up.

Key Words: Hip, Femoroacetabular impingement, Hip dislocation

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INTRODUCTION

Femoroacetabular impingement (FAI) is an abnormal abutment between femoral head-neck junction and acetabular rim or labrum. FAI has been studied for the last decade as an etiologic factor of osteoarthritis (OA) of hip. FAI commonly encountered in orthopedic practice may also be cause of intractable hip pain. Lavigne et al.[1] and Ganz et al.[2] have advocated early surgical intervention for symptomatic FAI because of its possible relationship with OA of hip. They have

Hip Pelvis 27(4): 241-249, 2015

introduced a safe approach called surgical hip dislocation (SHD) to hip joint without the risk of avascular necrosis of hip[1,2]. Others have used less invasive anterior mini-open (AMO) approach for surgical debridement of impingement as a modified Smith-Petersion approach for periacetabular osteotomy (PAO)[3,4]. Whichever surgical method is utilized, the surgical goal is to eliminate impingement of femoral head-neck junction on acetabular rim by removing bony outgrowth of femoral head-neck area, acetabular rim, or both. We may well think older age is a relative contraindiation for hip preservation surgery, but it is just surrogate for degree of cartilage damage. Therefore, is should not be used as absolute marker for cartilage status. As long as we know, there was only one report about the SHD for FAI in patients over the age of 40 years[5]. Therefore, here we report the short term results of open surgical treatment for symptomatic FAI in nonatheletic patients over 30 years without advanced arthritic change of hip joint.

In this report, we described the degree of clinical pain relief and the change in clinical function score in nonathletic patients over 30 years with open treatment for intractable hip pain caused by FAI. We also assessed the change of radiographic parameters for FAI after surgical treatment and any progression of radiological Tönnis grade (Table 1) at last follow-up. In addition, we described the complications associated with open treatment for FAI.

MATERIALS AND METHODS

1. Patients

Between May 2011 and June 2012, open surgical debridement was performed for thirteen FAI hips (11 patients) with hip pain persisting longer than 6 months. Hips with lateral center-edge angle (LCEA) more than 25° were included. Other inclusion criteria for recommendation of surgery were physical and radiological impingement sign, evidence of physeal closure, and Tönnis grade 0 or 1. The 11 patients (13 hips) were followed up for longer than 2 years (range, 24 months-29 months). These 11 patients included 7 females and 4 males with a mean age of 45 years (range, 33-60 years) (Table 2). The thirteen operated hips were able to be classified into cam predominant deformity (n=5), pincer predominant deformity (3 cases of global pincer, 1 case of superior focal pincer), or mixed deformities (n=4). Causes of operated FAI hips are shown (Table 2).

2. Operative Technique

AMO was operated in a supine position. The operative hip was draped from umbilicus to ankle with lower extremity freely manipulable. A 7- to 8-cm incision distal to anterior superior iliac spine was placed over the tensor fascia lata muscle. Care was taken in fascial incision to avoid injury of lateral femoral cutaneous nerve of thigh. After incision of proximal innominate aponeurosis, rectus femoris was elevated to expose the underlying capsule. With indirect head tenotomized, the rectus femoris was retracted medially along with iliopsoas to expose the medial capsule of the femoral neck. Retractors were placed medial and lateral to the femoral neck. T-shaped capsulotomy was performed. Cam deformity on the head-neck junction area was exposed for femoral osteoplasty (Fig. 1). This approach was used when cam decompression was necessary because it was excellent approach to anterior or anterolateral femoral head-neck junction.

SHD was operated by placing patient in a lateral decubitus position. A straight incision was done over greater trochanter area and extended distally as well as proximally. After the incision of fascia and trochanteric bursa, vastus lateralis was elevated at the trochanteric ridge. Gluteus medius and minimus were elevated and retracted superficial to the piriformis at a safe distance of 5 mm anterior to trochanteric overhang to protect

Table 1. Tönnis Grade

Grade 0	No signs of osteoarthritis.
Grade 1	Sclerosis of the joint with minimal joint space narrowing and osteophyte formation.
Grade 2	Small cysts in the femoral head or acetabulum with moderate joint space narrowing.
Grade 3	Advanced arthritis with large cysts in the femoral head or acetabulum, joint space obliteration, and severe deformity of the femoral head.

Table 2. Summary of 13 Operated Cohorts

Case	Sex/age (yr)	FAI type	Method	Cause of FAI	Labral refixation	UCLA activity score*	MHHS*	LCEA* (°)	AI* (°)	AA* (°)
1	M/60	Pincer	SHD	Coxa profunda with lateral overcoverage	○	5/6	61/85	58/43	−2.4/2.2	46/44
2	M/46	Mixed	AMO	Downward protrusion of AIIS; Coxa vara	×	6/7	73/85	-	-	64/53
3	F/48	Pincer	SHD	Coxa profunda with lateral overcoverage	○	5/5	73/85	48/35	−4.6/5.3	54/45
4	F/35	Pincer	SHD	Protrusio with lateral overcoverage	○	6/8	59/91	50/36	−5.5/3.4	78/35
5	F/38	Pincer	SHD	Coxa profunda with lateral overcoverage	○	5/8	57/89	45/31	−2.1/2.6	56/34
6	F/44	Cam	SHD	Idiopathic cam; Protrusio without lateral overcvrage	×	4/6	73/89	-	-	71/38
7	F/45	Cam	SHD	Capital slip	×	5/7	57/87	-	-	74/33
8	F/46	Cam	SHD	Capital slip	×	5/8	61/89	-	-	68/37
9	F/47	Mixed	SHD	Lateral overcoverage; Idiopathic cam	○	6/7	73/85	46/31	−1.7/2.8	56/43
10	F/48	Cam	AMO	Idiopathic cam	×	4/5	59/75	-	-	54/35
11	F/49	Mixed	SHD	Anterosuperior overcoverage; Idiopathic cam	○	4/5	59/75	-	-	57/38
12	F/50	Mixed	SHD	Protrusio with lateral overcoverage; Idiopathic cam	○	6/7	61/87	48/33	−2.4/3.5	62/47
13	F/51	Cam	AMO	Idiopathic cam	×	5/7	73/85	-	-	63/41

FAI: femoroacetabular impingement, UCLA: University of California at Los Angeles, MHHS: modified Harris hip score, LCEA: lateral center edge angle, AI: acetabular index, AA: alpha angle, M: male, F: female, SHD: surgical hip dislocation, AMO: anterior mini-open.

* Preoperative/postoperative.

medial femoral circumflex artery (MFCA). After careful digastric trochanteric osteotomy, the trochanteric fragment was retracted anteriorly. After removing remnant gluteus minimus, the capsule was exposed and a Z-shaped capsulotomy was performed while taking care not to injure retinacular vessel. The femoral head was then dislocated while the leg was flexed and externally rotated. Periosteal blushing was a consistent finding in all cases of this study (Fig. 2A). Acetabular labral takedown, bone trimming, and labral refixation were performed (Fig. 2B). Six o'clock was defined as the middle of acetabular notch for both right and left hips. Three o'clock was defined as anterior. Nine o'clock was defined as posterior. After acetabular procedure, femoral osteochondroplasty was performed as planned preoperatively (Fig. 2C). This approach was selected for case of mixed or pincer type because it allowed full exposure of acetabular cavity as well as femoral head.

Whichever approach might be chosen, the patients were allowed to ambulate using a wheel chair on the first postoperative day. Continuous passive motion of hip was performed from the first postoperative day to 2 months. From the seventh postoperative day, they were allowed to bear their weight using crutches as tolerably as they could.

3. Outcome

The thirteen operated cases were clinically evaluated with modified Harris hip score (MHHS) and University of California at Los Angeles (UCLA) activity level pre-operatively and on one year follow-up. Anterior and posterior impingements were evaluated at supine position. Anterior impingement was evaluated with hip in flexion and internal rotation. Posterior impingement was tested with hip in extension and external rotation. Lateral impingement was assessed on the lateral position with unaffected side down.

Hip Pelvis 27(4): 241-249, 2015

Orthograde anteroposterior radiogram was obtained in neutral rotation and tilt[6]. Center-collum-diaphysis angle, acetabular index (AI), and LCEA were measured from the radiogram. The depth of acetabular socket was evaluated by identifying any presence of coxa profunda or protrusio. The presence of acetabular retroversion was evaluated by cross-over sign, lateral wall sign, or ischial spine sign[6,7]. Alpha angle (AA) was measured on modified cross-table lateral view with hip maximally internally rotated or on modified Dunn view[8,9]. Three-dimensional computed tomogram (3D-CT) was performed to improve the diagnosis of cam FAI because the magnitude of AA might not be indicative of the size of deformity[10]. Magnetic resonance arthrogram (MRA) was done to ascertain any labral tear. Acetabular and femoral versions were evaluated on CT and MRA. Radiological impingement indices including LCEA, AI, and AA were measured at the last follow-up and compared to preoperative ones.

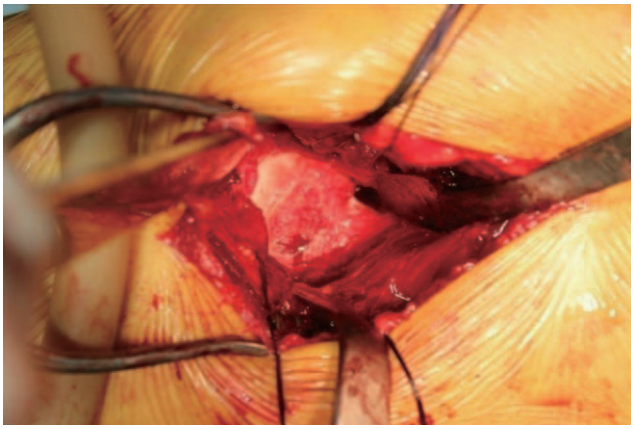

Fig. 1. Bony bump of anterior femoral head-neck junction removed by anterior mini-open.

Statistical analysis was performed to compare preoperative and last follow-up scores. Continuous data with non-normal distributions was reported as median with range or with inter-quartile range (IQR). Wilcoxon signed-rank test was used to compare preoperative and postoperative values. Normality for data sets was determined using the Kolmogorov-Smirnov test. Statistical analyses were performed using Microsoft Excel (Microsoft Inc., Redmond, WA, USA), IQR calculator (http://www.statisticshowto.com/calculators/interquartile-range-calculator/), and VassarStats Statistical Software Package (http://vassarstats.net/).

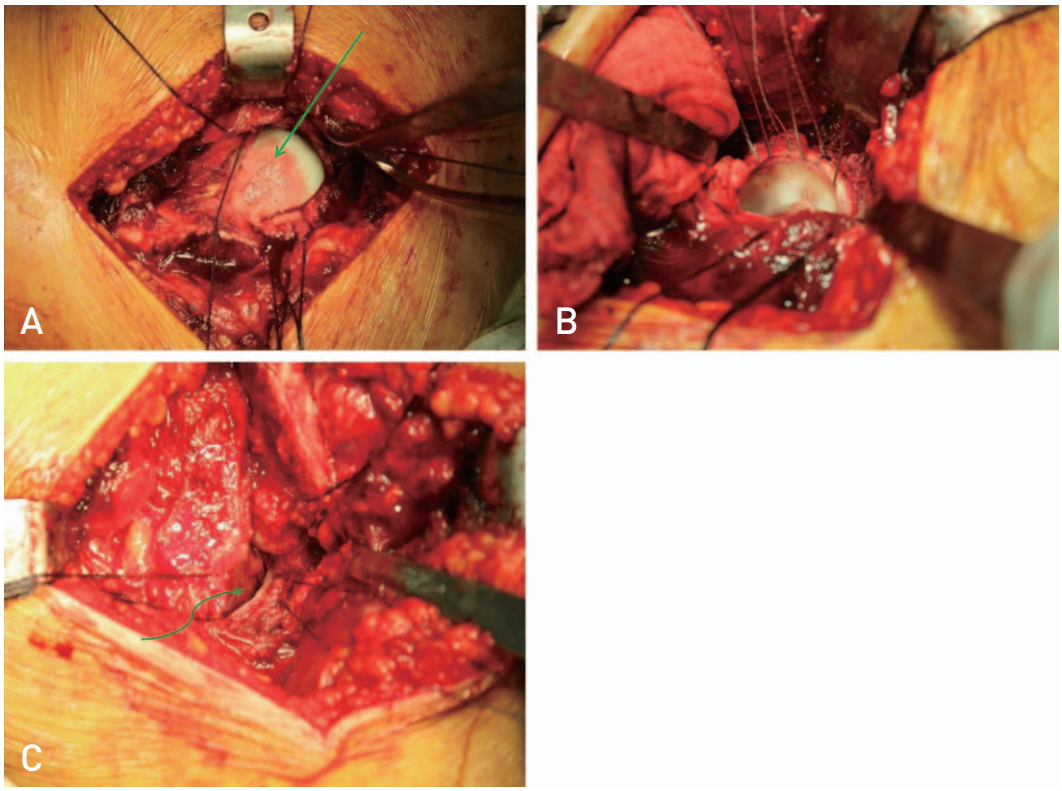

Fig. 2. (**A**) Periosteal blushing (arrow) in head neck junction. (**B**) Labral takedown, rim resection and labral refixation by surgical hip dislocation. (**C**) Clearance of impingement (arrow) after femoral osteochondroplasty.

Statistical significance was considered when *P*-value was less than 0.05.

RESULTS

1. Clinical results

Sixty-year-old subject had Tönnis grade of one. The others were graded as zero. Ten cases (four pincer, three cam, and three mixed) were corrected by SHD, while three cases (two cam and one mixed) were treated by AMO. Labral takedown and refixation were performed for seven cases (four pincer, three mixed). Femoral osteochondroplasty was performed for all thirteen cases (Table 2). Mean operative time was 180 min (range, 130-250 min). Mean estimated blood loss was 410 mL (range, 300-880 mL). At minimum follow-up of one year, most of them had substantial relief of preoperative pain ('much better' in 10 cases, 'better' in 3 cases) and improvement of hip range of motion. Median MHHS was significantly (*P*=0.0016) improved from 61 (range, 57-73) points preoperatively to 87 (range, 75-91) points at the last follow-up. All these included patients were not professional athletes but ordinary out-door activity persons. Their median UCLA activity level was 7 (range, 5-8) at the last follow-up, which was significantly (*P*=0.0024) improved compared to the preoperative median value of 5 (range, 4-6).

2. Radiological results

For seven cases (four pincer and three mixed) with labral takedown, rim trimming and refixation were performed. Of the seven cases, six were selected for measurement of LCEA and AI (Fig. 3). Because in one mixed deformity (case #11), anterior labrum alone was addressed without any effect upon LCEA, this case was excluded for measurement of LCEA and AI. The preoperative median LCEA value of the six cases was 48° (IQR, 46°/50°). The postoperative median LCEA value was 34° (IQR, 31°/36°). The preoperative median AI value of the six cases was –2.4 (IQR, –4.6/–2.1). The postoperative median AI value was 3.1 (IQR, 2.6/3.5) (Table 2). For all thirteen cases, femoral osteochondroplasties (Fig. 4) were

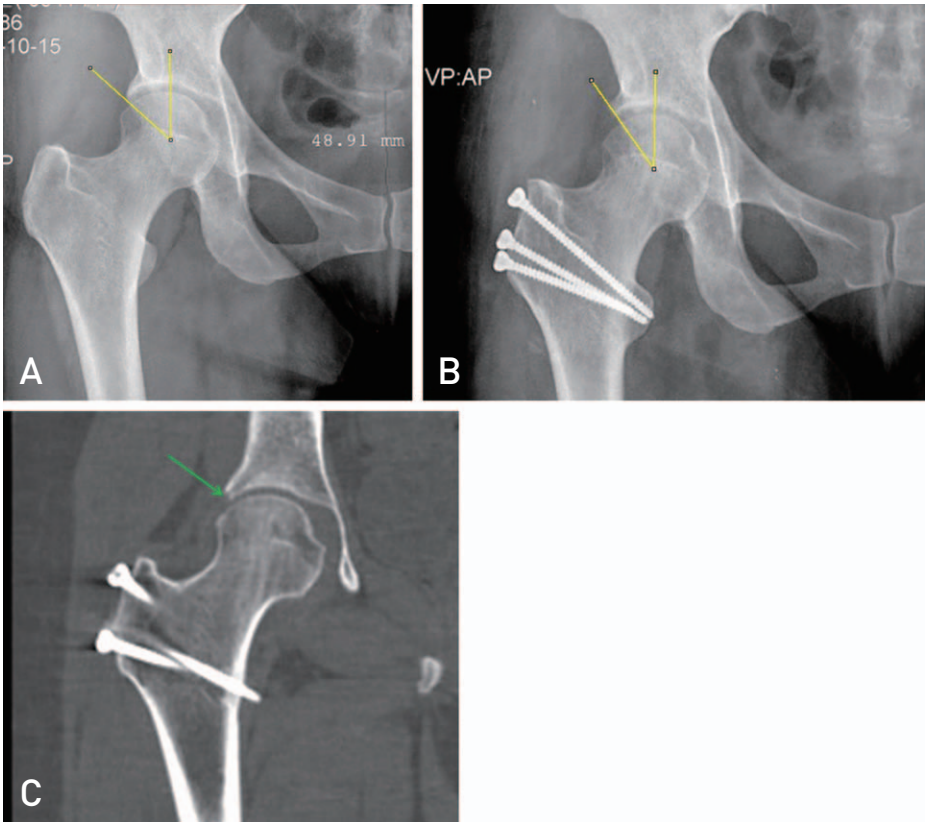

Fig. 3. Change of lateral center-edge angle. (**A**) 50° before acetabular osteochondroplasty; (**B**) 36° after acetabular osteochondroplasty. (**C**) The arrow indicates area of trimmed acetabular rim on computed tomogram.

Hip Pelvis 27(4): 241-249, 2015

performed. Median AA was decreased from preoperative value of 62° (IQR, 55°/69.5°) to 38° (IQR, 35°/44.5°) at last follow-up (Table 2). At the last follow-up, the Tönnis grade was stationary without any progression in all thirteen hips.

3. Complications

In all cases, MRA on one year follow-up revealed healing of refixed labrum without any evidence of secondary osteonecrosis. All osteotomized greater trochanters in SHD series revealed good union without any failure of fixation screws. One of three AMO cases had meralgia paresthetica.

DISCUSSION

In this study, we investigated short term results of open surgical treatment for symptomatic FAI and found favorable outcomes in clinical and radiological aspects. Nonsurgical treatment such as rehabilitation or observation may be used because there are many cases of nonsymptomatic FAI. But, It is usually proposed that early surgical intervention for treatment for FAI, besides providing relief of symptoms, may decelerate the progression of the degenerative process for young age group[11]. So, it is thought to be desirable to perform surgery for FAI patients fulfilling the inclusion criteria indicated in material and method.

Various surgical treatment approaches have been utilized to treat FAI[3,4,12-14]. SHD, advocated by Ganz et al.[2], is a technique with full access to the femoral head and acetabulum. It has been used for treating FAI[12-14]. So, it was thought to be the gold standard for FAI approach. Peters et al.[13] reported that at short-tem follow up, SHD treatment for FAI reduced pain and improved function with low complication in cases without substantial acetabular cartilage damage. Steppacher et al.[14] reported that at 5-year follow-up, 91% of patients with FAI treated with SHD, osteoplasty, or labral reattachment showed no total hip arthroplasty, progression of OA, or an insufficient clinical result. It is imperative to preserve MFCA in SHD to prevent secondary avascular necrosis of femoral head. Distal portion of modified Smith-Peterson approach used in performing PAO has been utilized to treat FAI. This was called AMO. Cohen et al.[3] and Parvizi et al.[4] reported promising mid-term results of FAI with AMO approach. This may be thought to be a less invasive approach than SHD. But, it permit limited field of view only and can be complicated with bothersome meralgia paresthetica[3,4]. A comprehensive comparison of these two approaches is impossible and beyond the scope of this study. But, briefly comparing these two surgical approaches concerning operative time and blood loss, we might well find that those of SHD were longer and more than those of AMO. The operative time of SHD became shortened from about 4 hours to 2 hours or so as operative skill improved. The amount of blood loss of SHD was slightly smaller than that of total hip arthroplasty, which was attributable to obviation of acetabular reaming and femoral neck cutting without resultant extensive exposure of cancellous bone which may cause copious bone bleeding.

Nowadays, arthroscopic technique is rapidly developing. Arthroscopic results for FAI are reported to be comparable to open treatment[15]. But all of the FAI deformites couldn't be corrected satisfactorily by

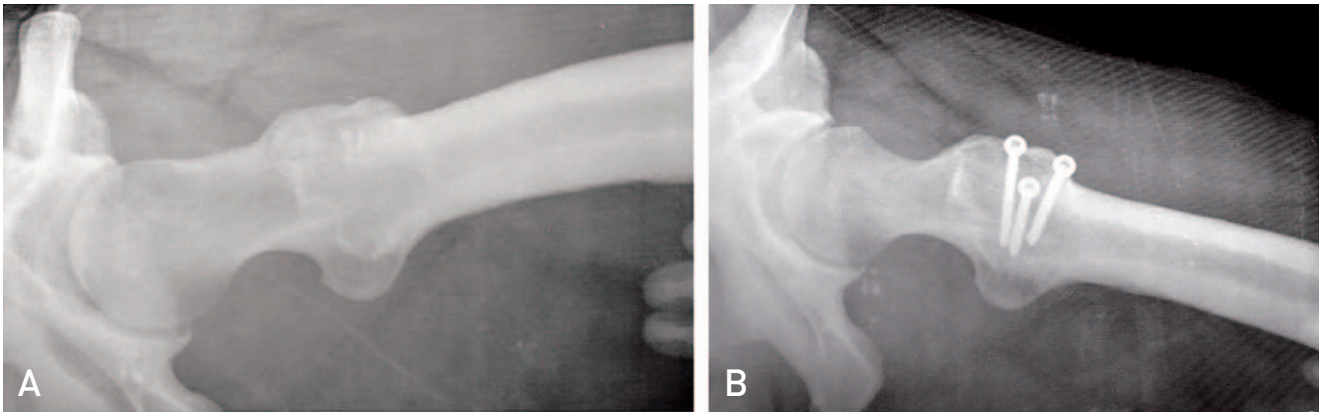

Fig. 4. Shape of femoral head-neck junction. (**A**) Before femoral osteochondroplasty. (**B**) After femoral osteochondroplasty.

arthroscopic technique alone. Its advantages include relative noninvasiveness and obviation of trochanteric osteotomy. It is primarily utilized for decompression of cam lesion. However, it might be very technically challenging to address labral refixation with competence. Not all the FAI deformities could be corrected satisfactorily by arthroscopic technique alone. We needed to be competent in open SHD or AMI treatment before switching to arthroscopic technique. Therefore, we have implemented open treatment first for FAI. From last year on, we have used arthroscopic method to address cam lesion. Hopefully we will be able to develop this technique skillfully so that we can address pincer lesion as well cam lesion in the future.

It is a focused concern whether to refix acetabular labrum or leave it alone in hip preservation surgery. Acetabular labrum is generally believed to create a seal to promote fluid-film lubrication of the hip joint and chondrocyte nutrition by limiting the rate of fluid egression from articular cartilage[16]. Its injury is thought to generate sufficient pain to require intervention[17]. Many authors have reported favorable clinical result of labral refixation or reconstructon rather than labrectomy[18,19]. Espinosa et al.[18] reported that patients treated with labral refixation recovered earlier with superior clinical and radiographic results compared to patients who had undergone resection of a torn labrum. Many authors have reported labral pathology as consistent findings concomitant with FAI. Peters et al.[13] found 82 labral abnormalities in 92 hips, including detachment, tear, degenerative, calcification, and absent from previous surgery. We couldn't find any gross labral pathology except for one case of acetabular global overcoverage with partially calcified labrum.

Acetabular chondral damage was also reported to be frequent findings in FAI, especially of the cam type. Beck et al.[20] found acetabular chondral damage in all 26 pure cam type FAIs with 10 chondral delaminations. Anderson et al.[21] reported acetabular cartilage delamination in 44% of patients who underwent surgical dislocation of hip. After labral takedown, we also scrutinized for acetabular chondral damage by probing peripheral area. Although we could not find gross delamination, defect, or flap tear, we frequently found dark reddish discoloration along the margin of acetabular cartilage, which was assumed to be area of longstanding impingement. We might have overlooked microscopic damages that might be present. Such results might also be due to the less frequent impingement or less degree of cam deformity in our cases. They might not be severe enough to cause acetabular chondral delamination or labral injury. In the corresponding area in the femoral head-neck junction, we were able to find periosteal blushing and/or fibrocystic degeneration consistently in all thirteen cases. Peters et al.[22] reported that this periosteal blushing indicating ecchymosis and osseous reaction is frequently observed in SHD for FAI and this area is delineated for femoral osteochondroplasty. This finding was consistent with that of this study. This reaction of the result of repetitive impingement of long duration is an inflammation biochemically, so may well be a cause of hip pain in absence of any labral or chondral damage. The degree of these changes might correlate with the severity of pain and indicate how wide femoral osteochondroplasty should be executed, which was also indicated by Peters et al[22].

Concerning contributing factors to early failure of SHD of FAI, it has been reported that excessive acetabular trimming, OA, and increased age and weight were major culprits[14]. Older age may also be related to poor outcome after SHD for FAI treatment. Steppacher et al.[14] reported that one of the strongest predictors for failure was age >40 years, which represented a relative contraindication. Increased or decreased BMI was also reported to be related to early failure[14,23]. The cartilage overload caused by increased BMI might lead to early failure. On the other hand, decreased BMI might be related to early conversion to total hip replacement if combined with microinstability caused by rim resection[23].

There may be complications related to open treatment. Concerning complications related to SHD treatment for FAI, Yun et al.[24] reported a 20% incidence of trochanteric nonunon requiring refixation. Beaulé et al.[25] reported 9 (24%) cases of trochanteric bursitis requiring screw removal and one trochanteric nonunion needing refixation. Our series didn't show any case of nonunion or malunion at the last follow-up except one (case #4) in which slight malreduction of osteotomized greater trochanter led to my decision to rereduce and refix the osteotomy site postoperatively. This trochanteric osteotomy-related complication might be related to technical problem. We drilled and tapped three holes toward lessor trochanter before flip osteotomy of the greater trochanter to reduce osteotomized fragment and insert screws easily. One major concern of SHD may be

Hip Pelvis 27(4): 241-249, 2015

the development of avascular necrosis of femoral head. In a large series of SHD, there was no reported case of avascular necrosis[2]. As long as MFCA is preserved, SHD is a safe approach. The technique of preserving MFCA is well described with particular interest to osteotomy plane superficial to piriformis[2]. The main disadvantage of AMO approach is the possibility of injuring lateral femoral cutaneous nerve. Cohen et al.[3] reported that mild meraglia paresthetica caused by stretching occurred in 9 of 44 (20%) cases after AMO surgery. They were resolved within 1 year postoperatively in all patients[3]. To prevent this from happening, it is recommended to incise fascia lata encasing tensor fascia lata and sartorius about 1 cm laterally away from the interval between these two muscles. We encountered this complication in one case (case #10) of three AMO cases, which was abated at the last follow-up. Two of SHD cases had residual pain, the cause of which was not verified clearly. The plausible causes are inadequate decompression, secondary instability, or intra-articular adhesions etc[26].

There are several limitations of this study. First, this study was retrospectively designed. Second, very limited number of patients were included in the study. Third, there was no control group. Fourth, the follow-up period was short. However, the number of FAI requiring operation is never enough to perform prospective, randomized, and controlled study. Although we cannot inform whether correction of impingement by open method may prevent early onset OA of hip in non-athletics because of these limitations, it was ascertained that there were really bony impingements in presumed FAI patients that caused intractable hip pain in non-athletics. It was also determined that pain originated from impingement could be reproducibly and expectedly relieved in these patients at short term follow-up. In addition, we found that hip function could be improved significantly after surgical restoration of femoro-acetabular clearance at short term follow-up.

CONCLUSION

Symptomatic FAI was surely a cause of intractable hip pain. Open treatment of FAI was a reliable and effective treatment method with little or no complications in symptomatic FAIs patients over the age of 30 years without advanced arthritic change of hip joint at short term follow-up.

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