■ HIP

Arthroscopy of the hip for patients with mild to moderate developmental dysplasia of the hip and femoroacetabular impingement

OUTCOMES FOLLOWING HIP ARTHROSCOPY FOR TREATMENT OF CHONDROLABRAL DAMAGE

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The purpose of this study was to determine patient-reported outcomes of patients with mild to moderate developmental dysplasia of the hip (DDH) and femoroacetabular impingement (FAI) undergoing arthroscopy of the hip in the treatment of chondrolabral pathology. A total of 28 patients with a centre-edge angle between 15° and 19° were identified from an institutional database. Their mean age was 34 years (18 to 53), with 12 female and 16 male patients. All underwent labral treatment and concomitant correction of FAI. There were nine reoperations, with two patients requiring revision arthroscopy, two requiring periacetabular osteotomy and five needing total hip arthroplasty.

Patients who required further major surgery were more likely to be older, male, and to have more severe DDH with a larger alpha angle and decreased joint space.

At a mean follow-up of 42 months (24 to 89), the mean modified Harris hip score improved from 59 (20 to 98) to 82 (45 to 100; p < 0.001). The mean Western Ontario and McMaster Universities Osteoarthritis Index score improved from 30 (1 to 61) to 16 (0 to 43; p < 0.001). Median patient satisfaction was 9.0/10 (1 to 10). Patients reported excellent improvement in function following arthroscopy of the hip.

This study shows that with proper patient selection, arthroscopy of the hip can be successful in the young patient with mild to moderate DDH and FAI.

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Developmental dysplasia of the hip (DDH) accounts for between 20% and 40% of cases of osteoarthritis in adults under the age of 50.[1-7] Periacetabular osteotomy (PAO), which aims to correct acetabular architecture before the onset of degenerative changes, has become an established form of treatment for patients with DDH and in some patients, acetabular retroversion.[8-11] There is now good evidence that PAO leads to a satisfactory outcome and survival of the osteotomy in patients with severe DDH, defined as a centre-edge angle (CEA) of Wiberg[11] of < 15°.[12,13] However, little has been written about the use of less invasive procedures for patients with mild to moderate DDH.

Femoroacetabular impingement (FAI) has become increasingly recognised during the last ten years with the development of improved imaging techniques. FAI with chondrolabral dysfunction has also been observed in patients with DDH. A recent study from Japan found that, in 176 patients with groin pain, 39% had mild DDH and 30% had radiological evidence of FAI.[14] In another study, 47% of 63 patients with FAI had radiological evidence of DDH[15] with the presence of labral pathology dependent on FAI.

In patients with co-existing DDH and FAI, arthroscopy of the hip may be used to treat the articular and labral pathology, but arthroscopy alone cannot address the abnormalities of bony architecture. As such, the role and timing of arthroscopy in adults with DDH has not been well defined. Some authors have reported improvement in pain following arthroscopic intervention in such patients.[16,17] However, the outcomes of arthroscopy are poorer in patients with DDH. Parvizi et al[18] reported minimal symptomatic relief with labral debridement in patients with DDH. The treatment of labral pathology has evolved with evidence supporting labral repair and reconstruction.[19] Arthroscopy with repair or reconstruction of the labrum, little or no acetabuloplasty and concomitant correction of FAI has been described in the management of patients with mild DDH.[20]

The purpose of this study was to determine the outcome of this procedure in patients with mild to moderate DDH and FAI who undergo arthroscopy of the hip for the treatment of chondrolabral pathology. We hypothesised that patients with mild to moderate DDH

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Fig. 1a

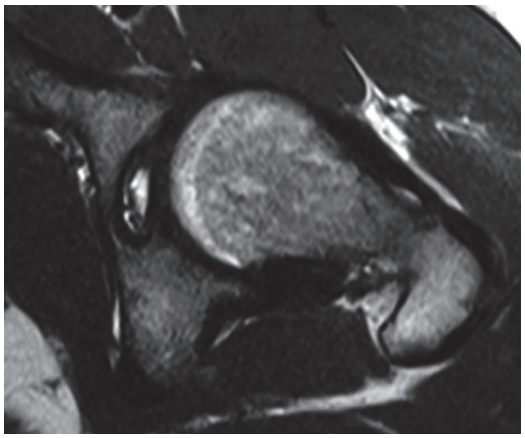

Fig. 1b

a) Anteroposterior radiograph of the left hip of a female patient with a centre-edge angle of 17° and b) axial view of an MRI image of the same patient with an alpha angle of 72°.

would demonstrate post-operative improvement in clinical scores, high satisfaction, little morbidity, and a low rate of subsequent surgical intervention.

Patients and Methods

Following institutional review board approval, all patients with DDH who underwent arthroscopy between June 2005 and March 2009 were identified from a prospectively-collected database. DDH was classified using the criteria of Byrd and Jones;[16] it was considered mild to moderate if the CEA was between 15° and 19°. All patients with DDH who were aged > 18 years, and who underwent primary arthroscopy with labral repair or reconstruction, were eligible for inclusion in the study. Patients were excluded if there had been previous surgery to the hip, if their surgery involved labral debridement without repair or reconstruction, if they had osteonecrosis, or were severely dysplastic with a CEA of > 15°. Demographic data including age at time of surgery, body mass index, and gender were recorded. All data were collected prospectively and reviewed retrospectively. Other data included time from onset of symptoms to arthroscopy, arthroscopic findings, surgical treatment and pre-operative radiographic measurements. Pre- and post-operative data also included the modified Harris hip score[21] (mHHS), the Western Ontario and McMaster Universities Osteoarthritis Index[22] (WOMAC), the 12-Item Short Form Health Survey[23] (SF-12, including physical and mental components) and the Hip Outcome Score (HOS, subdivided into activities of daily living (ADL) and sports scores).[24] Satisfaction with the outcome was graded on a ten-point ordinal scale with 10 being very satisfied and 1 being very unsatisfied. Re-operations such as conversion to total hip arthroplasty (THA, PAO and/or revision arthroscopy, were recorded.

Radiographic assessment. The radiographic evaluation was performed with anteroposterior (AP) pelvic, cross-table lateral and the modified Dunn view radiographs.[25] MRI without contrast was obtained pre-operatively in order to evaluate the acetabular labrum, ligamentum teres, chondral surfaces, and other soft-tissue structures and to measure the alpha angle. The CEA, acetabular inclination (Tonnis angle),[26] crossover sign and Sharp's angle were measured on the AP view, and the alpha angle was measured using the axial view of the MRI scans[26-28] (Fig. 1). Radiographs were evaluated to determine which type of FAI was present. Hips were considered to have a pincer type deformity if there was a crossover sign, and a cam type deformity if the alpha angle was > 50°. The presence of subspinal impingement was documented. Cam, pincer, and subspinal impingement were all confirmed at time of arthroscopy by dynamic examination.

Arthroscopy. All patients underwent arthroscopic surgery, performed by a single surgeon (MJP), with a technique which has been previously described.[28,29] A modified supine approach was used with distraction of between 8 mm and 10 mm. A diagnostic arthroscopy was performed and any pathology of the labrum, chondral surfaces, ligamentum teres or impingement was documented. An attempt was made to preserve as much native labrum as possible by repairing it using the standard arthroscopic technique. If the labrum was found to be incompetent, reconstruction was undertaken using an iliotibial band autograft.[28] FAI was also treated at the time of arthroscopy. Cam impingement was treated with femoral head-neck osteoplasty. Decompression of pincer impingement was minimal in order to preserve acetabular cover. Subspinal decompression was performed as needed.

The cartilage of the acetabulum and femoral head were thoroughly assessed and any pathology was treated. Chondral delamination or fissuring was treated with chondroplasty. Microfracture was performed if a discrete Outerbridge grade IV chondral lesion was identified (Fig. 2).[30]

Post-operative management. All patients underwent a similar post-operative protocol as described by Wahoff and Ryan.[31] This consisted of a four-phase programme focused on progression to return to athletics and normal activity. Patients

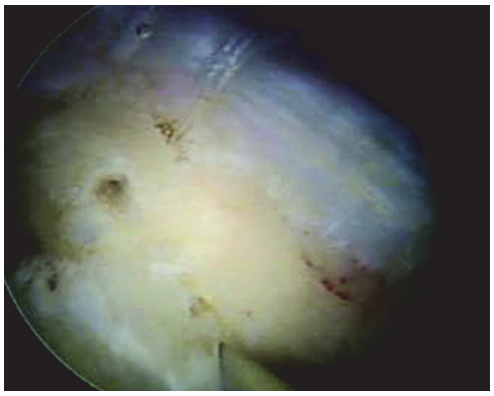

Fig. 2a

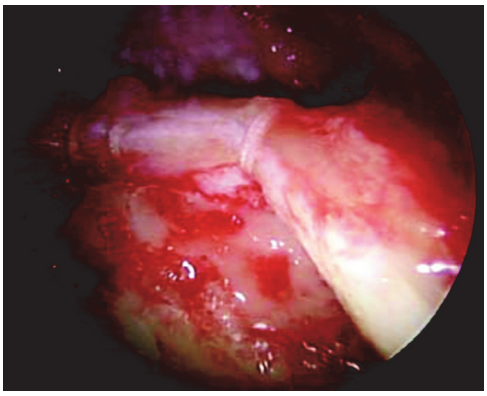

Fig. 2b

Left hip, viewed anterosuperiorly from the mid-anterior portal; the images show a) microfracture of the hip with holes approximately 3 mm to 4 mm apart and b) bleeding from the holes following microfracture.

Table I. Demographics and radiographic findings in patients with mild dysplasia treated with hip arthroscopy

n	28
Mean age (yrs) (range)	34 (18 to 53)
Female:male	12:16
Side (left:right)	12:16
Mean body mass index (kg/m^2) (range)	25.6 (18.5 to 31.7)
Mean lateral centre-edge angle (°) (range)	17.7 (15 to 19)
Mean acetabular inclination (Tonnis angle) (°) (range)	15.9 (7 to 25)
Greater than 10°	25
Mean Sharp's angle (°) (range)	43.5 (35 to 56)
Mean alpha angle (°) (range)	72 (53 to 95)
Joint space < 2.0 mm	6
Crossover sign	15

were permitted to partially bear weight through a flat foot with a maximum of 20 pounds of pressure placed through the affected leg for a minimum of 14 days; this was extended to six weeks in the ten patients who underwent microfracture. A continuous passive movement machine was used for six to eight hours per day while weight-bearing was restricted (either two or six weeks depending on whether microfracture was performed) and a brace was worn to prevent rotation and extension of the hip while walking. An anti-rotation boot was used at night for two weeks post-operatively to prevent excessive external rotation of the hip during sleep.

Statistical analysis. Fisher's exact test was used to determine associations between categorical variables. For comparison of continuous variables between groups, the independent samples *t*-test was used when the variable was normally distributed and the Mann–Whitney U test was used when the variable was not. Pearson and Spearman correlations were used to compare continuous variables, again depending on whether the underlying variable was normally distributed. All statistical analyses were performed using SPSS, Version 20 (IBM Inc., Armonk, New York). A p-value of < 0.05 was considered statistically significant.

Results

A total of 28 patients met the inclusion criteria. The demographic and radiographic data are summarised in Table I. The three patients with an AI of < 10° had CEAs of 17°, 17°, and 19°, respectively. A total of 17 (61%) patients were aged < 40 years at the time of arthroscopy. The findings at arthroscopy are shown in Table II. All patients underwent labral treatment and concomitant correction of FAI. There were six frayed/degenerative labral tears and 22 full thickness or detached labral tears. A total of 20 patients underwent labral repair and eight underwent labral reconstruction with an 8 mm iliotibial band autograft. Patients were considered to require labral reconstruction if the labrum did not provide a suction seal with the femoral head on dynamic examination. Of the hips with labral reconstruction, two hips had labral hypertrophy, one had an ossified labrum and five had frayed/degenerative labra. Four of the eight hips requiring labral reconstruction also had a partial tear of ligamentum teres. One hip had an isolated pincer deformity, three had an isolated cam lesion, and 24 had combined lesions. Nine patients required microfracture for chondral lesions (one femoral head, seven acetabulum, one both surfaces). There were no peri-operative complications.

Table II. Findings at arthroscopy

Labrum tear location		
	Anterosuperior	16
	Posterosuperior	12
Articular cartilage damage location		
	Femoral Grade 3/4	11
	Acetabular Grade 3/4	14
Ligamentum teres		
	Partial tear	15
	Complete tear	4
	Synovitic	2
	Hypertrophic	3

Table III. Pre-operative and surgical findings in three patient groups. Continuous variables are presented as means with ranges

	THA (n = 5)	**PAO (n = 2)**	**No further major surgery(n = 21)**
Age (yrs)	46 (36 to 53)	25(18 to 32)	32 (18 to 52)
Female:male	1:4	1:1	10:11
BMI (kg/m^2)	27.9 (18.8 to 31.7)	24 (20 to 28)	25.2 (18.5 to 31.3)
Months from onset of symptoms	18.9 (3 to 34)	29.7 (14 to 49)	15.4 (1 to 75)
Lateral CE angle (°)	17.6 (16 to 19)	17 (15 to 19)	17.8 (15 to 19)
Acetabular inclination (Tonnis angle) (°)	15.1 (11 to 22)	21 (18 to 24)	15.5 (7 to 25)
Sharp's angle (°)	40.6 (35 to 50)	50° (44° to 56 °)	44 (39 to 50)
Alpha angle (°)	76.2 (53 to 95)	69.5° (59° to 80°)	71.6 (57 to 85)
Joint space < 2.0 mm	5	0	1
Crossover sign	1	2	12
Type of FAI	2 cam; 2 cam + pincer; 1 pincer	2 cam + pincer	1 cam; 20 cam + pincer
SF-12 PCS	38.6 (25.4 to 51.8)	47.2 (42.3 to 52)	42.2 (27.4 to 58.2)
SF-12 MCS	48 (23.6 to 66.2)	53.9 (51.4 to 56.4)	54.2 (30.1 to 64)
WOMAC	45 (23 to 61)	14 (8 to 20)	28.2 (1 to 44)
mHHS	52.6 (23 to 81)	63 (56.70)	59.4 (32 to 100)
HOS ADL	61.9 (28.1 to 95.3)	87.5(85.9 to 89.1)	67.9 (39.1 to 85.9)
HOS sport	39.9 (0 to 93.8)	58.3 (44.4 to 72.2)	40 (2.8 to 69.4)
Labral treatment repair:recon	2:3	1:1	17:4
Microfracture	5	0	6

THA, total hip arthroplasty; PAO, periacetabular osteotomy; BMI, body mass index; FAI, femeroacetabular impingement; SF-12, 12-item short form health survey; PCS, physical component score; MCS, mental component score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; mHHS, modified Harris hip score; HOS, hip outcome score; ADL, activities of daily living

A total of five (18%) patients (four male and one female; mean age of 42 years) underwent conversion to a THA at a mean of two years (11 months to five years) following initial arthroscopy. All hips had < 2 mm of joint space at the time of arthroscopy. Two had microfracture on the acetabulum and one had microfracture on the acetabulum and femoral head. Three had labral reconstruction. The ligamentum teres was completely torn in one hip and partially torn in four hips. Two patients underwent PAO at three months (aged 32) and five years following surgery (age 18). In both, the indication for PAO was progressive pain and instability, and an inability to perform ADL. Comparison of pre-operative findings and surgical findings are shown in Table III. Patients who required THA were older (mean of 42 years *vs* 31 years for the remaining patients; p = 0.015), more likely to be male, had an initial joint space of < 2 mm, with higher alpha angles, and had lower pre-operative clinical scores. Four had a mHHS of < 55 points and HOS ADL of < 70.

Of the remaining 21 hips, two (9.5%) required revision arthroscopy for adhesions at 11 months and 12 months following surgery, respectively. A total of 21 patients, including two who underwent a revision, completed outcome questionnaires at a mean follow-up from the time of arthroscopy of 42 months (24 to 89). The mean mHHS improved from 59 (20 to 98) pre-operatively to 82 (45 to 100) post-operatively (p < 0.001). The mean WOMAC score improved from 30 (1 to 61) to 16 (0 to 43) (p < 0.001). The mean HOS ADL and Sport scores improved significantly from 68.3 (28 to 95) and 41 (0 to 93.8) to 85 (63 to 100) and 75.5 (38.9 to 100) (p < 0.001, p < 0.001), respectively. The median satisfaction was 9.0 (1 to 10). The mean SF-12 Physical Component score also significantly improved (42.7 to 54; p = 0.001), while the mean SF-12 Mental Component Score did not change (54 to 53.8; p = 0.431).

Age at the time of surgery was correlated with pre-operative WOMAC score (r = 0.434; p = 0.049). The older the patient at the time of arthroscopy, the higher

pre-operative WOMAC, equating to a greater degree of disability. However, the age of the patients did not correlate with the outcomes at final follow-up. Sharp's angle was correlated with mHHS (r = 0.64; p = 0.008); however, no other radiographic parameter correlated with outcome. Time from the onset of symptoms to surgery was correlated with satisfaction at follow-up (r = 0.518; p = 0.033). Patients who had a longer time from onset to surgery had higher satisfaction. Satisfaction was correlated with SF-12 PCS (r = 0.50; p = 0.038); WOMAC (r = -0.792; p = 0.001); mHHS (r = 0.499; p = 0.041) at follow-up. In these scores, patients with higher scores had higher function (SF12-PCS, mHHS) and less disability (WOMAC).

Discussion

This study demonstrated that arthroscopic surgery of the hip improved the outcome in patients with mild to moderate DDH and FAI. A total of nine (32%) patients underwent a further operation, with two undergoing revision arthroscopy, two requiring PAO and five, all of whom were aged > 36 years, requiring THA. Patients who required THA or PAO were older, with larger alpha angles and limited joint space, and were more likely to be male. The clinical improvement presented in this study is similar to the findings of other studies using clinical outcomes in patients undergoing arthroscopy of the hip for the treatment of FAI without DDH.[29,32]

Over the past decade, PAO has become widely accepted as a form of treatment for symptomatic DDH in adults, with satisfactory results reported at short- and medium-term follow-up.[13,33] However, the preferred treatment for the patient with mild to moderate DDH has not been determined. Ross et al[34] showed that failed arthroscopy of the hip and the need for PAO are most commonly observed in young female patients with mild to moderate DDH. They showed that patients present approximately two years after arthroscopy with persistent or recurrent symptoms and major functional limitations. However, it was unclear what procedures were performed at the primary arthroscopy or if any labral pathology was left untreated. Perry et al[35] suggested that patients with mild DDH and traumatic labral pathology may benefit from labral repair; however, they considered the co-existence of these pathologies to be rare. Patients with DDH may also benefit from capsular plication. Domb et al described the importance of capsular plication and labral preservation in the arthroscopic treatment of borderline DDH.[20] Domb et al also drew attention to the importance of correcting the underlying morphological abnormality.[36] Domb et al described labral pathology in 14 of 17 hips with DDH with most being Seldes type I tears, which correlated to increased stress at the acetabular edge of the labrum.[36]

In the current study, we found only a few degenerative labral tears and they were seen in patients with limited joint space. None of the previous studies addressed the co-existence of FAI or its implication in the development of labral pathology.

DDH and FAI are known to co-exist. Paliobeis and Villar[15] found that up to 47% of 63 patients treated for FAI had radiographic evidence of DDH, and Domb et al[36] identified a cam deformity in ten of 16 patients who had a CEA of < 17°. Good results have been reported in patients with milder forms of DDH. Byrd et al[16] reported that arthroscopy of the hip in 48 patients with either DDH or borderline DDH resulted in a mean improvement of the mHHS of 27 points at a mean follow-up of 27 months, similar to the findings in our study. In this study, we found that patients who subsequently required THA were significantly older than those who did not require THA (42 *vs* 31; p = 0.015). Limiting arthroscopy of the hip to patients aged > 35 years with mild to moderate DDH may help to avoid the subsequent need for THA.

Previous studies have shown that pincer FAI is not frequently seen in DDH.[37] One of the difficulties is the lack of an objective definition for pincer impingement. It is not defined by an angle than can be measured. We have documented the presence of a crossover sign and noted pincer impingement on dynamic examination. Earlier studies did not perform dynamic examinations and the demographics of the patients may have varied from those studied here. The patients in this study were very active and participated in high level sports with extreme ranges of movement.

This study has limitations. Some patients undergo PAO and then have an arthroscopy of the hip to treat chondrolabral lesions associated with FAI. These patients were excluded from this study. We included only those patients who chose to undergo arthroscopy rather than PAO. Another limitation is the short follow-up. It is not known whether these patients will eventually require PAO and at what age. Longer follow-up is required to determine if this arthroscopic treatment of FAI in patients with mild DDH will be durable. Finally, the current two-dimensional measurements of DDH that are performed on radiographs may not be sufficient. CT scans are being used more frequently in the pre-operative evaluation of patients with DDH; however, the exposure to additional radiation has limited their widespread use and CT scans are not routinely used to assess patients with DDH by the senior author.

The goal of arthroscopy of the hip in the patient with DDH is to treat intra-articular damage and improve function and outcomes. The decision to perform an arthroscopy in these patients requires strict patient selection criteria and education of the patients on the risks of failure as they may require THA or PAO following arthroscopy. Other authors have shown that a PAO may still preserve the joint in patients who do not respond to arthroscopy.[38,39] It is not clear which patients will require these additional major procedures; however, in this study, the patients at greatest risk were older males who had larger alpha angles and decreased joint space. Longer follow-up is required to determine if there is a greater need for further interventions.

Author contributions:
K. Fukui: Study design, data collection, data interpretation, initial manuscript draft, editing and final manuscript preparation.
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K. K. Briggs: Study conception, study design, data collection, data analysis, data interpretation, initial manuscript draft, editing and final manuscript preparation.
M. J. Philippon: Study conception, study design, data collection, data interpretation, initial manuscript draft, editing and final manuscript preparation.

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References

1. **Cooperman DR, Wallensten R, Stulberg SD.** Acetabular dysplasia in the adult. *Clin Orthop Relat Res* 1983;175:79–85.
2. **Croft P, Cooper C, Wickham C, Coggon D.** Osteoarthritis of the hip and acetabular dysplasia. *Ann Rheum Dis* 1991;50:308–310.
3. **Jacobsen S, Sonne-Holm S, Søballe K, Gebuhr P, Lund B.** Hip dysplasia and osteoarthrosis: a survey of 4151 subjects from the Osteoarthrosis Substudy of the Copenhagen City Heart Study. *Acta Orthop* 2005;76:149–158.
4. **Johnsen K, Goll R, Reikerås O.** Acetabular dysplasia as an aetiological factor in development of hip osteoarthritis. *Int Orthop* 2009;33:653–657.
5. **Lievense AM, Bierma-Zeinstra SM, Verhagen AP, Verhaar JA, Koes BW.** Influence of hip dysplasia on the development of osteoarthritis of the hip. *Ann Rheum Dis* 2004;63:621–626.
6. **Terjesen T.** Residual hip dysplasia as a risk factor for osteoarthritis in 45 years follow-up of late-detected hip dislocation. *J Child Orthop* 2011;5:425–431.
7. **Wiberg G.** Acetabular dysplasia and osteoarthritis. *Acta Chir Scand* 1939;83:5–135.
8. **Ganz R, Klaue K, Vinh TS, Mast JW.** A new periacetabular osteotomy for the treatment of hip dysplasias. Technique and preliminary results. *Clin Orthop Relat Res* 1988;232:26–36.
9. **Siebenrock KA, Schoeniger R, Ganz R.** Anterior femoro-acetabular impingement due to acetabular retroversion. Treatment with periacetabular osteotomy. *J Bone Joint Surg [Am]* 2003;85-A:278–286.
10. **Hartig-Andreasen C, Troelsen A, Thillemann TM, Søballe K.** What factors predict failure 4 to 12 years after periacetabular osteotomy? *Clin Orthop Relat Res* 2012;470:2978–2987.
11. **Wiberg G.** Studies on dysplastic acetabulum and congenital subluxation of the hip joint with special reference to the complications of osteoarthritis. *Acta Chir Scand* 1939;83:29–38.
12. **Steppacher SD, Tannast M, Ganz R, Siebenrock KA.** Mean 20-year followup of Bernese periacetabular osteotomy. *Clin Orthop Relat Res* 2008;466:1633–1644.
13. **Matheney T, Kim YJ, Zurakowski D, Matero C, Millis M.** Intermediate to long-term results following the bernese periacetabular osteotomy and predictors of clinical outcome: surgical technique. *J Bone Joint Surg [Am]* 2010;92-A(suppl1Pt 2):115–129.
14. **Mori R, Yasunaga Y, Yamasaki T, et al.** Are cam and pincer deformities as common as dysplasia in Japanese patients with hip pain? *Bone Joint J* 2014;96-B:172–176.
15. **Paliobeis CP, Villar RN.** The prevalence of dysplasia in femoroacetabular impingement. *Hip Int* 2011;21:141–145.
16. **Byrd JW, Jones KS.** Hip arthroscopy in the presence of dysplasia. *Arthroscopy* 2003;19:1055–1060.
17. **Meftah M, Rodriguez JA, Panagopoulos G, Alexiades MM.** Long-term results of arthroscopic labral debridement: predictors of outcomes. *Orthopedics* 2011;34:588–592.
18. **Parvizi J, Bican O, Bender B, et al.** Arthroscopy for labral tears in patients with developmental dysplasia of the hip: a cautionary note. *J Arthroplasty* 2009;24(suppl):110–113.
19. **Ayeni OR, Adamich J, Farrokhyar F, et al.** Surgical management of labral tears during femoroacetabular impingement surgery: a systematic review. *Knee Surg Sports Traumatol Arthrosc* 2014;22:756–762.
20. **Domb BG, Stake CE, Lindner D, El-Bitar Y, Jackson TJ.** Arthroscopic capsular plication and labral preservation in borderline hip dysplasia: two-year clinical outcomes of a surgical approach to a challenging problem. *Am J Sports Med* 2013;41:2591–2598.
21. **Byrd JW, Jones KS.** Prosepctice Analysis of Hip Arthroscopy with 2-year Follow-up. *Arthroscopy* 2000;16:578–587.
22. **Rothenfluh DA, Reedwisch D, Müller U, et al.** Construct validity of a 12-item WOMAC for assessment of femoro-acetabular impingement and osteoarthritis of the hip. *Osteoarthritis Cartilage* 2008;16:1032–1038.
23. **Ware JE, Snow KK, Kosinski M, Gandek B.** SF-36 *Health Survey Manual and Interpretation Guide*. The Health Institute: Boston, MA, 1993.
24. **Martin RL, Philippon MJ.** Evidence of validity for the hip outcome score in hip arthroscopy. *Arthroscopy* 2007;23:822–826.
25. **Clohisy JC, Carlisle JC, Beaulé PE, et al.** A systematic approach to the plain radiographic evaluation of the young adult hip. *J Bone Joint Surg [Am]* 2008;90-A(suppl 4):47–66.
26. **Guevara CJ, Pietrobon R, Carothers JT, Olson SA, Vail TP.** Comprehensive morphologic evaluation of the hip in patients with symptomatic labral tear. *Clin Orthop Relat Res* 2006;453:277–285.
27. **Nötzli HP, Wyss TF, Stoecklin CH, et al.** The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. *J Bone Joint Surg [Br]* 2002;84-B:556–560.
28. **Ejnisman L, Philippon MJ, Lertwanich P.** Acetabular labral tears: diagnosis, repair, and a method for labral reconstruction. *Clin Sports Med* 2011;30:317–329.
29. **Philippon MJ, Briggs KK, Yen YM, Kuppersmith DA.** Outcomes following hip arthroscopy for femoroacetabular impingement with associated chondrolabral dysfunction: minimum two-year follow-up. *J Bone Joint Surg [Br]* 2009;91-B:16–23.
30. **Crawford K, Philippon MJ, Sekiya JK, Rodkey WG, Steadman JR.** Microfracture of the hip in athletes. *Clin Sports Med* 2006;25:327–335.
31. **Wahoff M, Ryan M.** Rehabilitation after hip femoroacetabular impingement arthroscopy. *Clin Sports Med* 2011;30:463–482.
32. **Byrd JW, Jones KS.** Arthroscopic management of femoroacetabular impingement: minimum 2-year follow-up. *Arthroscopy* 2011;27:1379–1388.
33. **Garras DN, Crowder TT, Olson SA.** Medium-term results of the Bernese periacetabular osteotomy in the treatment of symptomatic developmental dysplasia of the hip. *J Bone Joint Surg [Br]* 2007;89-B:721–724.
34. **Ross JR, Clohisy JC, Baca G, Sink E, ANCHOR Investigators.** Patient and disease characteristics associated with hip arthroscopy failure in acetabular dysplasia. *J Arthroplasty* 2014;29(suppl):160–163.
35. **Perry KI, Trousdale RT, Sierra RJ.** Hip dysplasia in the young adult: an osteotomy solution. *Bone Joint J* 2013;95-B(supplA):21–25.
36. **Domb BG, Lareau JM, Baydoun H, et al.** Is intraarticular pathology common in patients with hip dysplasia undergoing periacetabular osteotomy? *Clin Orthop Relat Res* 2014;472:674–680.
37. **Mei-Dan O, McConkey MO, Brick M.** Catastrophic failure of hip arthroscopy due to iatrogenic instability: can partial division of the ligamentum teres and iliofemoral ligament cause subluxation? *Arthroscopy* 2012;28:440–445.
38. **Kain MS, Novais EN, Vallim C, Millis MB, Kim YJ.** Periacetabular osteotomy after failed hip arthroscopy for labral tears in patients with acetabular dysplasia. *J Bone Joint Surg [Am]* 2011;93-A(suppl2):57–61.
39. **Kim KI, Cho YJ, Ramteke AA, Yoo MC.** Peri-acetabular rotational osteotomy with concomitant hip arthroscopy for treatment of hip dysplasia. *J Bone Joint Surg [Br]* 2011;93-B:732–737.