Arthroscopic Offset Restoration in Femoroacetabular Cam Impingement: Accuracy and Early Clinical Outcome

Lisca Stähelin, M.D., Thomas Stähelin, M.D., Brigitte M. Jolles, M.D., M.Sc., and Richard F. Herzog, M.D.

Purpose: The purpose of this study was to determine the accuracy of arthroscopic restoration of femoral offset as well as the early clinical outcome of arthroscopic debridement and femoral offset restoration and whether there is a correlation between accuracy and outcome. **Methods:** Twenty-two patients with symptomatic femoroacetabular cam impingement underwent arthroscopic correction of the femoral offset and debridement. The α angle was measured with magnetic resonance imaging preoperatively and postoperatively for quantification of the offset, and the clinical status was determined by documenting the impingement sign, range of motion, intensity of pain on a visual analog scale, Nonarthritic Hip Score, and complications preoperatively and 6 months postoperatively. **Results:** The α angle improved from a mean of 75° to 54°. Internal rotation increased from a mean of 5° to 22°, flexion increased from a mean of 107° to 124°, and the pain score decreased from a mean of 5.8 to 1.4. The Nonarthritic Hip Score increased from a mean of 49 to 74 points. No major complications were encountered. Patients with early osteoarthritis did substantially worse than those without it. The α angle did not correlate with any clinical outcome measure. **Conclusions:** The femoral offset can be precisely restored via an arthroscopic technique in the treatment of femoroacetabular cam impingement. The early clinical outcome of arthroscopic offset restoration and debridement is good in patients with no or only mild osteoarthritis. The accuracy of correction is not correlated with the early clinical outcome. **Level of Evidence:** Level IV, therapeutic case series. **Key Words:** Hip arthroscopy—Femoroacetabular impingement—Cam—Offset—Restoration.

Femoroacetabular cam impingement is defined as an insufficiently concave head-neck junction (offset) abutting against the acetabular rim.[1] Patients have pain in the groin that is typically triggered by internal rotation (IR) and adduction during hip flexion.[2] The significance of this pathology as a cause of early coxarthritis has been realized in the last few years.[1] Offset restoration is performed to alleviate the symptoms and delay the onset of coxarthritis. Initially, offset restoration was only performed as an open procedure.[3-6] Less invasive arthroscopic techniques are now being used to an increasing extent. With the exception of one study that reported detailed, promising early results,[7] most reports are primarily technical descriptions,[8-12] providing scarce information about clinical results. One disadvantage of the arthroscopic technique compared with the open procedure is the fact that, when performing the former, the surgeon has difficulties in orienting himself or herself to the location and extent of the required bone resection. This may lead to insufficient correction and residual impingement or even excessive resection, which is associated with the risk of femoral neck fracture.[12] Published data concerning the planned extent of offset

From the Hôpital Orthopédique de la Suisse Romande and University of Lausanne (L.S., T.S., B.M.J.), Lausanne, and Kantonales Spital Sursee Wolhusen (R.F.H.), Wolhusen, Switzerland.

The authors report no conflict of interest.

Address correspondence and reprint requests to Lisca Stähelin, M.D., Hôpital Orthopédique de la Suisse Romande and University of Lausanne, Avenue Pierre-Decker 4, CH-1005 Lausanne, Switzerland. E-mail: lisca@stahelin.ch

0749-8063/08/2401-7241$34.00/0
doi:10.1016/j.arthro.2007.08.010

Note: To access the supplementary Table 1 accompanying this report, visit the January issue of *Arthroscopy* at www.arthroscopyjournal.org.

correction and the precision of the subsequent procedure are scarce.

The senior author (R.F.H.) developed an arthroscopic technique of offset restoration that allows viewing by controlled endoscopic capsulotomy and believed that it would provide the basis for accurate corrections of the femoral offset with good early clinical outcome. Thus the purpose of this study was to determine the accuracy of this technique and to assess the early clinical outcome of arthroscopic offset restoration and debridement as well as to determine whether there is a correlation between accuracy and outcome.

METHODS

From September 2004 to April 2005, patients with symptomatic femoroacetabular cam impingement who were scheduled to undergo arthroscopic offset correction and willing to participate were enrolled in this prospective case-series study approved by the local ethics committee. Exclusion criteria were previous surgery in the index hip and narrowing of the joint space by half on radiographs, corresponding to Tönnis grade III.[13] No patient had radiologic signs of excessive ventral coverage such as coxa profunda, protrusio coxae, or a crossover sign.[14] The duration of follow-up was 6 months.

The extent of the offset was determined by the α angle, according to Nötzli et al.,[15] as seen on preoperative and postoperative magnetic resonance images (Fig 1). On the basis of the mean α value of 42° ± 2° (range, 33° to 48°) registered in a healthy population of 35 subjects,[15] an α angle of 50° or less was deemed normal. One patient refused to undergo postoperative magnetic resonance imaging. Restoration of the offset was considered accurate if a normal α angle or a reduction of the α angle of 20° or greater was achieved; because, according to the recommendations of an in vitro stress study,[16] no more than 20% of the femoral neck diameter should be resected to avoid an increased risk of fracture, we did not seek to reach a normal α in patients with high preoperative α values and we sought a difference of 20° or greater instead.

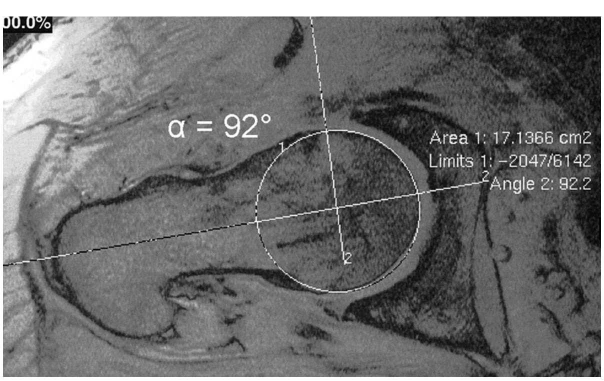

FIGURE 1. Oblique transversal plane on magnetic resonance imaging, parallel to longitudinal axis of femoral neck and through center of femoral head. The angle between the longitudinal axis and the head-neck junction is termed α; the head is approximated to a circle. The pathologic femoral offset in this case (α = 92°) should be noted.

The following was determined by clinical examination preoperatively and at 6 months after surgery: impingement sign,[2] range of motion in the supine position, intensity of pain on a visual analog scale, and Nonarthritic Hip Score (NAHS).[17] Complications were also documented. The NAHS is specifically designed to register hip pain and function in young patients. It is divided into 4 subunits: pain, mechanical symptoms, function, and level of activity. The maximum score is 100 points. Analogous to the Harris Hip Score, the values are divided into the following categories: very good (90 to 100 points), good (80 to 89 points), moderate (70 to 79 points), poor (60 to 69 points), and very poor (<60 points). All patients were available for clinical follow-up.

The operation was performed by the senior author (R.F.H.) with the patient in the supine position, with the hip flexed to 20°. Under image amplification, a distal anterolateral portal is placed 2 cm anterior to the greater trochanter and the camera is inserted in an extracapsular location. A second, ventral-inferior portal is positioned lateral of the sartorius tendon at the inferior border of the femoral head. With a shaver (Smith & Nephew Endoscopy, Andover, MA) and a vaporizer (ArthroCare, Sunnyvale, CA), the ventral part of the capsule is exposed and a longitudinal arthrotomy is performed parallel to the neck by use of the ArthroCare device (Fig 2). Traction is applied. If necessary, the capsulotomy is extended in a T-shaped fashion. Through the ventral-inferior portal, a palpation stick is placed in the calcar region, and with the hip flexed at 20°, the inferior part of the capsule is held aside, the palpation stick working like a Hohmann retractor (Fig 3). Another working portal is localized at the superior border of the femoral neck, lateral of the first working portal. Under traction, the central compartment is examined. The anterosuperior junction between the labrum and acetabulum is inspected and palpated with great care, because damage to the labrum and cartilage is mostly located in this area in cam impingement. Diffuse chondromalacia is smoothed with

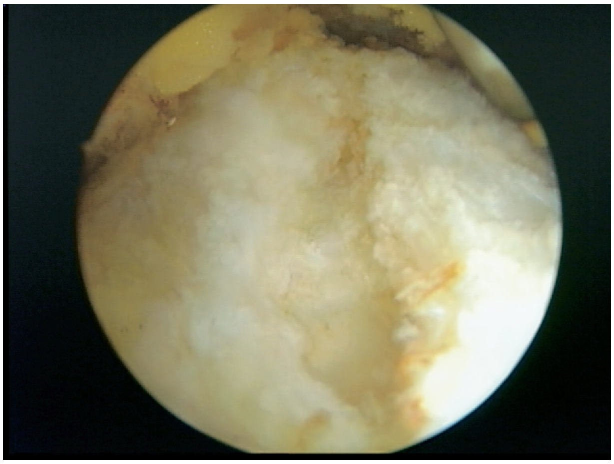

FIGURE 2. After exposure of the capsule, a longitudinal arthrotomy is performed parallel to the femoral neck axis using a vaporizer. If necessary, the capsulotomy is extended in a T-shaped fashion following the acetabular rim.

the shaver, delaminated cartilage is removed, and zones of bare bone are microfractured.[18] Labral tears at the base are smoothed with the ArthroCare device. In larger tears with degeneration of the labrum, partial labral resection is performed. Short tears in a labrum of good quality are sutured by means of one 3.5-mm, double-armed suture anchor (TwinFix; Smith & Nephew Endoscopy).[19]

For offset correction (Fig 4), traction is released and the foot is removed from the fixation so that the hip is freely movable. Given the large opening of the capsule, as well as the fact that the capsule is held at the side, the camera can be drawn back widely. This facilitates exact assessment of the different curvatures at the head-neck junction to determine the limits of the pathologic protrusion. The craniocaudal midpoint of the protrusion is notched before the bone is abraded. From the notch, the bone abrasion is successively extended in the cranial and caudal direction via a 5.5-mm stone cutter (Smith & Nephew Endoscopy). Through the superior portal, the inferior part of the offset is restored; to complete the correction, the portals need to be changed. In no case did the surgeon gain the impression that the offset extended laterally to the level of the blood vessels entering the cranium. The depth of the abrasion and its extension at the surface are continued until no femoroacetabular contact is detected optically at 110° flexion, 20° IR, and 20° adduction. By use of an image amplifier, the surgeon ensures that no more than 20% of the femoral neck diameter has been resected, in keeping with the recommendations of an in vitro stress study.[16]

To prevent ossification, patients were given indomethacin for 10 days postoperatively. They were instructed to practice weight-bearing during pain or partial weight-bearing with 15 kg for 6 weeks after microfracturing.

For statistical analysis, the patients' data were entered in an Excel spreadsheet (Microsoft, Redmond, WA) and analyzed with Stata 8.2 software (Stata, College Station, TX). The entire body of data was analyzed as a whole, separately for each group, and between the baseline and follow-up investigations for each observation. Means, SDs, ranges, and 95% confidence intervals were analyzed. The data of 22 patients were analyzed via nonparametric tests. Wilcoxon signed rank tests were applied with $\alpha = .05$ as the level of significance. Spearman rank correlation coefficients were calculated and regressions were performed to analyze the relation between hip joint mobility, pain, function scores, and postoperative α angles. The difference in α between the preoperative and postoperative time points was also analyzed. With 10 patients in each group of α angles, considering an α level of .05, a clinically meaningful difference of 15°, and an SD of 11° in hip mobility (IR and flexion), we obtained a power of 82%.

RESULTS

The study participants were 7 women and 15 men aged on average 42 years (range, 18 to 67 years), with a mean body mass index of 24.9 (range, 20 to 31). Of the patients, 14 had no radiologic signs of arthritis, 5

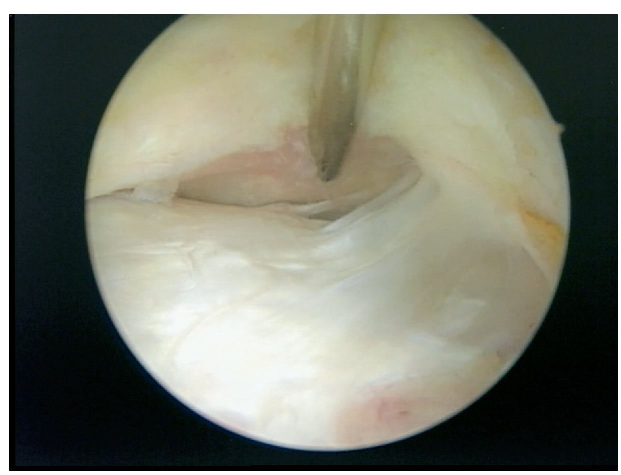

FIGURE 3. A palpation stick is placed in the calcar region, and with the hip flexed at 20°, the inferior part of the capsule is held aside, the palpation stick working like a Hohmann retractor.

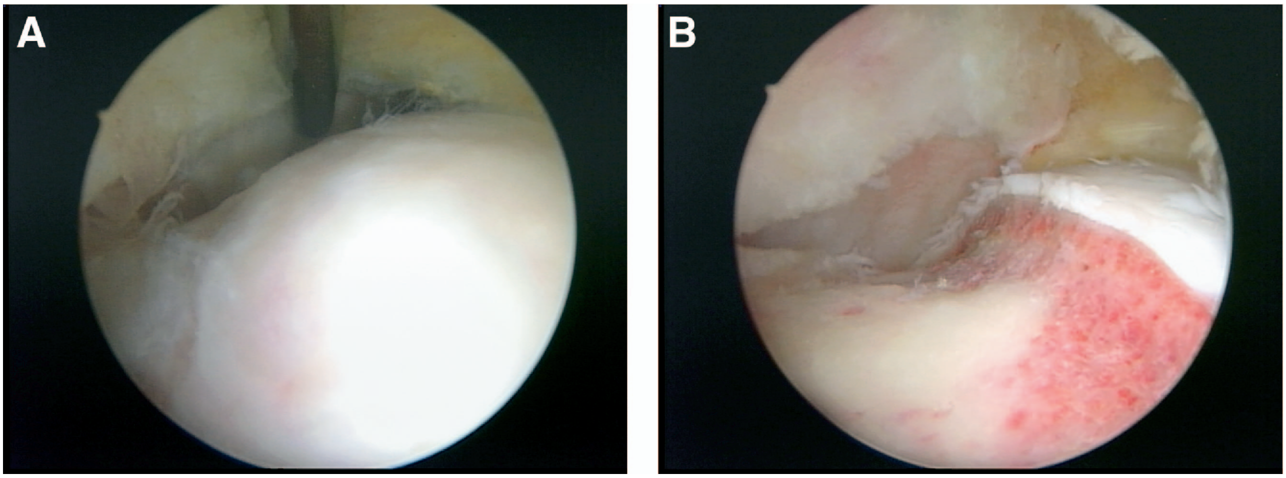

FIGURE 4. Femur (A) before and (B) after offset restoration. The inferior part of the capsule is held aside with a palpation stick, allowing the anterolateral bump to be visualized. If necessary, a T-shaped extension of the capsulotomy is performed, as seen in B.

had grade I arthritis, and 3 had grade II arthritis. The demographic data as well as the detailed results for each patient are summarized in Table 1 (online only, available at www.arthroscopyjournal.org).

The labrum was damaged in all patients. The tears were located anterosuperiorly and started on the articular side; the extent of the damaged zone was less than 3 cm, and sometimes there was considerable fatty degeneration. Minor labral damages were smoothed, and in 13 patients larger lesions with degeneration required partial resection of the damaged region as well as smoothing. In 2 patients a short tear was found in a labrum of good quality, allowing refixation by means of one 3.5-mm, double-armed suture anchor. Diffuse chondromalacia was found in 14 patients and was smoothed with the shaver. Delaminated hyaline cartilage at the acetabular rim, with exposed subchondral bone, was seen in 7 patients; the delamination was removed, the edges smoothed, and microfracturing performed.

The preoperative α angle was 75.1° $\pm$ 12.7° (range, 58° to 100°). After the intervention, the α angle was reduced by a minimum of 2°, by a maximum of 38°, and on average by 21.3°. The reduction was significant (Fig 5). The postoperative α angle was normal ($\leq$50°) in 10 patients and remained pathologic in 11 patients (>50°). Of these 11 patients, 8 showed a marked preoperative offset of 80° or greater. In 7 of

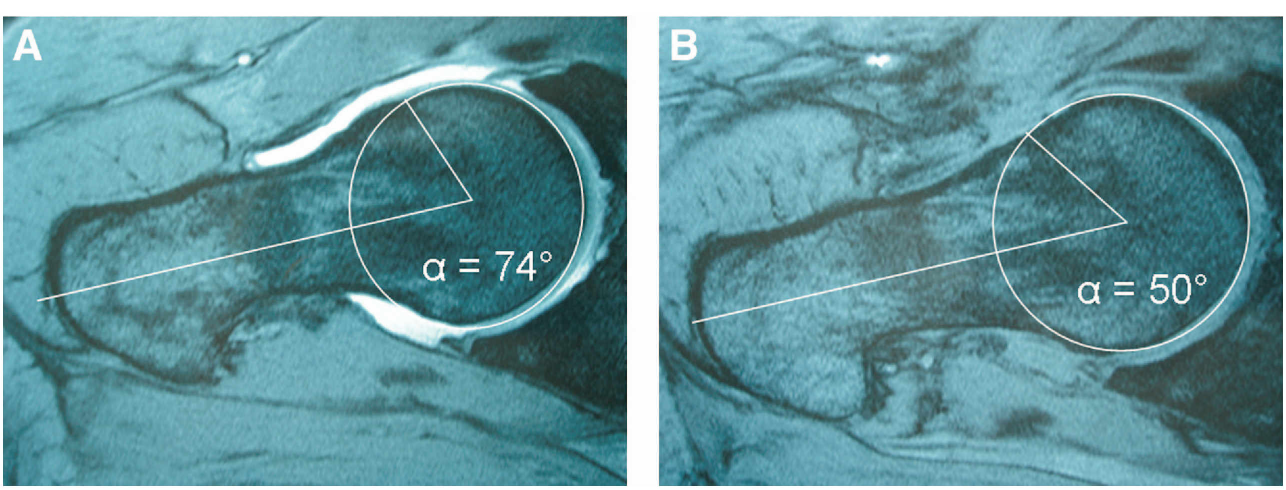

FIGURE 5. α Angle on magnetic resonance imaging (A) before and (B) after arthroscopic offset correction. In this patient, α was reduced from 74° to 50°.

TABLE 2. *Overall Results*

	Preoperatively	6 mo Postoperatively	Difference
α (°)	75.1 ± 12.7 (58 to 100)	53.8 ± 9.2 (40 to 74)	21.3 ± 9.9 (2 to 38)
Impingement	n = 22	n = 5	n = 17
Flexion (°)	108 ± 14.3 (80 to 135)	124.1 ± 16.8 (70 to 150)	16.4 ± 14.8 (−10 to 50)*
IR (°)	4.5 ± 9.7 (−20 to 20)	22.3 ± 13.3 (5 to 50)	17.7 ± 10.6 (0 to 35)*
Adduction (°)	19.8 ± 6.1 (10 to 35)	21.8 ± 6.1 (10 to 30)	2.1 ± 5.3 (0 to 10)
Visual analog scale score	5.8 ± 2.1 (1 to 9)	1.4 ± 1.7 (0 to 6)	4.4 ± 3.0 (−2 to 9)*
NAHS	49.5 ± 19.6 (15 to 92.5)	74.0 ± 19.5 (32.5 to 97.5)	23.1 ± 24.2 (−13.8 to 76.3)*

NOTE. Data are given as mean ± SD (range).
*Statistically significant ($P < .05$).

these 11 patients with a postoperative α angle of greater than 50°, a difference of 20° or greater was achieved and the correction was considered accurate. In the remaining 4 patients, the achieved correction of α was 2°, 4°, 10°, and 19° (Fig 6) and was judged inaccurate.

Patients with an α of 50° or less and those with an α of greater than 50° postoperatively did not differ significantly from each other with respect to any of the investigated parameters—either in terms of absolute values or the difference. Neither the postoperative α value nor the difference in α achieved by correction was correlated with any of the ascertained clinical parameters.

Seventeen patients had no signs of impingement postoperatively; five, however, did show a positive impingement sign (Table 2). Mobility was significantly improved with an increase in IR and flexion, whereas adduction remained practically unchanged. The visual analog scale score was significantly reduced from a mean of 5.8 preoperatively to 1.4 at 6 months after surgery. Eight patients had absolutely no pain at 6 months after surgery. The NAHS was significantly reduced by a mean of 24.3 points; postoperatively, 5 patients had a very good score (90 to 100 points), 7 had a good score (80 to 89 points), 5 had a moderate score (70 to 79 points), and 5 had a poor score (<70 points) (Table 2). Of the 5 patients with a poor postoperative NAHS, 3 had grade II arthrosis whereas 1 had grade I arthrosis. In one of these patients the NAHS had worsened by 13 points at 6 months after surgery. Patients with grade I and II coxarthrosis had significantly poorer results for each of the determined parameters than those with no visible signs of degeneration on standard radiologic investigation (Table 3).

With regard to complications, hypoesthesia occurred in 6 cases, which disappeared in all cases within 3 months at the latest. The hypoesthesia was located in the dorsum of the foot in 3 cases, in the region innervated by the nervus cutaneus femoris lateralis in 2, and in the scrotum in 1.

DISCUSSION

By use of the surgical technique described in this report, the offset could be normalized in nearly one half of the patients (n = 10). In 11 patients, 8 of whom

TABLE 3. *Comparison of Results in Patients With Arthrosis (Tönnis Grade I or II) and Patients Without Arthrosis (Tönnis Grade 0)*

	Tönnis Grade 0			Tönnis Grade I or II		
	Preoperatively	6 mo Postoperatively	Difference	Preoperatively	6 mo Postoperatively	Difference
α (°)	71.4 ± 11.6	51.6 ± 9.6	19.8 ± 8.0	82.4 ± 9.9	58.0 ± 5.4	25.9 ± 10.4
Impingement	n = 14	n = 1		n = 8	n = 4	
Flexion (°)	112 ± 14.1	132 ± 8.0*	20 ± 15.7	98 ± 11.1	106 ± 21*	7.8 ± 10.6
IR (°)	8 ± 8.0*	29 ± 11.0*	21 ± 8.5	−1.1±8.7*	9.4 ± 6.8*	10.6 ± 10.7
Visual analog scale score	5.8 ± 2.3	0.6 ± 0.6*	5.2 ± 2.4	5.8 ± 1.6	3.2 ± 2.0*	2.6 ± 3.0
NAHS	52 ± 20	83 ± 12.5*	31 ± 22	45 ± 12	56 ± 19*	10 ± 20

NOTE. Data are given as mean ± SD.
*Statistically significant difference between the 2 groups ($P < .05$).

showed a severe preoperative offset pathology with an α angle of 80° or greater, the offset remained pathologic. In 7 of these 11 cases, the correction was considered accurate, because marked improvement with a difference of 20° or greater was achieved. The correction was insufficient in 4 of 21 patients, in whom α remained greater than 50° and the difference was less than 20°. A comparison of the accuracy of correction with that achieved in other studies would have been useful. However, only 1 published study has provided data on the α angle after arthroscopic offset correction without mentioning target values: the authors achieved a reduction of α from 69.9° (range, 56° to 84°) to a normal mean value of 47° ± 5°.[7] In comparison, the mean preoperative α in our study was higher with 75.1° (range, 58° to 100°), which might explain the higher postoperative value of 53.8° ± 9°. The mean α correction of 22.9°[7] is similar to that of 21.3° achieved in our study.

With 53%, the percentage of pathologic postoperative α values is high. We suspect that these results—in addition to the stated reason for some highly pathologic preoperative α values, where correction to 50° was not sought to avoid a fracture—reflect the inadequacy of the α angle to represent the amount and accuracy of the offset correction rather than the inadequacy of the surgical technique. Although quantification of offset by way of the α angle is a standard procedure and the only one available at the time being, α is measured in the oblique transversal plane that passes through the center of the femoral head, parallel to the longitudinal axis of the femoral neck,[15] and thus only expresses the ventral component of the offset, which is usually located ventrocranially.[20] Determination of the parameter in further rotated planes around the femoral neck axis and calculation of the respective standard values would be valuable to describe the offset comprehensively. We do not think that the operative technique failed to correct the offset, given that, intraoperatively, no patient had a remaining impingement at 110° flexion, 20° IR, and 20° adduction and because, 6 months postoperatively, only 5 of 22 patients showed a positive impingement sign. The absence of a correlation between α and all of the ascertained clinical parameters may be attributed to the various possible sources of pain arising from different layers of tissue, as well as the limited number of patients, but might also reflect the inadequacy of α to represent the pathology of cam impingement.

In our series the NAHS value was improved from 24.3 points before surgery to 74.0 points at 6 months after surgery; very good postoperative values were registered in 5 cases, good values in 7, moderate values in 5, and poor values in 5. Guanche and Bare[10] achieved a comparable improvement of the NAHS from 75 to 95 points on average, registered 16 months after arthroscopic offset correction in 10 patients. In our study pain was reduced, mobility improved, and signs of impingement eliminated in most patients. Wettstein and Dienst[7] achieved comparable results 9 months after arthroscopic offset correction in 15 patients. We found that 3 patients with grade II arthrosis and 1 patient with grade I arthrosis accounted for 4 of the 5 poor results achieved based on the NAHS. Generally, patients with grade I and II coxarthrosis had significantly poorer results for each of the determined parameters than those without it. An earlier study on arthroscopic offset correction already drew attention to the poor outcome of this procedure in the presence of arthrosis.[10] Thus, the less invasive procedure of offset correction does not warrant any modification of the recommendation made by Beck et al.[6]; on the basis of their results of open offset correction, they advise against the use of this procedure beyond grade II coxarthrosis.

Transient hypoesthesia was encountered in 6 cases. Most of these were caused by traction and could be avoided after changing the perineal posts and shoes for ones with better padding. The best means of prevention is to keep the traction time as short as possible.

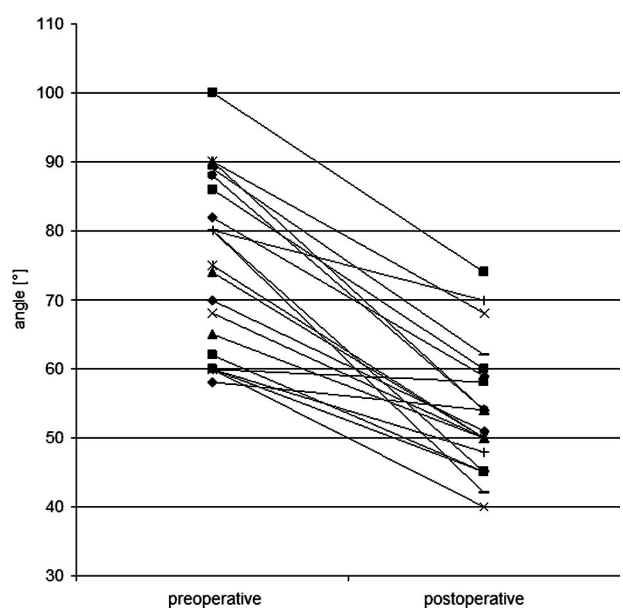

FIGURE 6. α Angle in 21 patients before and after arthroscopic offset correction. Seventeen patients achieved a normal offset of 50° or less or a difference of 20° (or both).

Other than the inadequacy of the α angle to reflect the offset pathology discussed previously, a limitation of this study is the short follow-up of 6 months, which allows the early benefit of the treatment to be assessed. Long-term results will be needed to assess the true value of this procedure. Further limitations are the small number of patients and the inclusion of a heterogeneous population, because patients with different grades of coxarthrosis were included. The repercussion of this was discussed earlier.

CONCLUSIONS

The femoral offset can be precisely restored via an arthroscopic technique in the treatment of femoroacetabular cam impingement. The early clinical outcome of arthroscopic offset restoration and debridement is good in patients with no or only mild osteoarthritis. The accuracy of correction is not correlated with the early clinical outcome.

REFERENCES

1. Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock K. Femoroacetabular impingement: A cause for osteoarthritis of the hip. *Clin Orthop Relat Res* 2003:112-120.
2. Klaue K, Durnin CW, Ganz R. The acetabular rim syndrome. A clinical presentation of dysplasia of the hip. *J Bone Joint Surg Br* 1991;73:423-429.
3. Lavigne M, Parvizi J, Beck M, Siebenrock K, Ganz R, Leunig M. Anterior femoroacetabular impingement—Part I. Techniques of joint preserving surgery. *Clin Orthop Relat Res* 2004:61-66.
4. Ganz R, Gill T, Gautier E, Ganz K, Krügel N, Berlemann U. Surgical dislocation of the adult hip. *J Bone Joint Surg Br* 2001;83:1119-1124.
5. Murphy S, Tannast M, Young-Jo K, Buly R, Millis M. Debridement of the adult hip for femoroacetabular impingement. *Clin Orthop Relat Res* 2004:178-181.
6. Beck M, Leunig M, Parvizi J, Boutier V, Wyss D, Ganz R. Anterior femoroacetabular impingement: Part II. Midterm results of surgical treatment. *Clin Orthop Relat Res* 2004:67-73.
7. Wettstein M, Dienst M. Hip arthroscopy for femoroacetabular impingement. *Orthopade* 2006;35:85-93 (in German).
8. Bare AA, Guanche CA. Hip impingement: The role of arthroscopy. *Orthopedics* 2005;28:266-273.
9. Crawford JR, Villar RN. Current concepts in the management of femoroacetabular impingement. *J Bone Joint Surg Br* 2005; 87:1459-1462.
10. Guanche C, Bare A. Arthroscopic treatment of femoroacetabular impingement. *Arthroscopy* 2006;22:95-106.
11. Philippon MJ, Schenker ML. Arthroscopy for the treatment of femoroacetabular impingement in the athlete. *Clin Sports Med* 2006;25:299-308, ix.
12. Sampson T. Arthroscopic treatment of femoroacetabular impingement. *Tech Orthop* 2005;20:56-62.
13. Tönnis D, Heinecke A. Acetabular and femoral anteversion: Relationship with osteoarthritis of the hip. *J Bone Joint Surg Am* 1999;81:1747-1770.
14. Reynolds D, Lucas J, Klaue K. Retroversion of the acetabulum. A cause of hip pain. *J Bone Joint Surg Br* 1999;81:281-288.
15. Nötzli H, Wysss T, Stoecklin C, Schmid M, Treiber K, Hodler J. The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. *J Bone Joint Surg Br* 2002;84:556-560.
16. Mardones R, Gonzales C, Chen Q, Zobitz M, Kaufman K, Trousdale R. Surgical treatment of femoroacetabular impingement: Evaluation of the effect of the size of the resection. *J Bone Joint Surg Am* 2005;87:273-279.
17. Christensen C, Althausen P, Mittleman M, Lee J, McCarthy J. The nonarthritic hip score: Reliable and validated. *Clin Orthop Relat Res* 2003:75-83.
18. Byrd J. Hip arthroscopy: Surgical indications. *Arthroscopy* 2006;22:1260-1262.
19. Kelly B, Weiland D, Schenker M, Philippon M. Arthroscopic labral repair in the hip: Surgical technique and review of the literature. *Arthroscopy* 2005;21:1496-1504.
20. Ito K, Minka MA II, Leunig M, Werlen S, Ganz R. Femoroacetabular impingement and the cam-effect. A MRI-based quantitative anatomical study of the femoral head-neck offset. *J Bone Joint Surg Br* 2001;83:171-176.

TABLE 1. *Demographic Data and Results for Each Patient*

Patient No.	Sex	Age (yr)	Side	Tönnis Grade	Arthroscopy	α (°)		IR (°)		Flexion (°)		Impingement		NAHS		VAS	
						Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	M	41	R	0	PLR, Sm	82	59	20	30	130	130	1	0	92.50	85.00	3	1
2	M	27	L	0	PLR, MF	62	45	0	20	95	135	1	0	53.0	91.3	5	0
3	M	62	R	I	Sm	74	50	0	10	100	110	1	1	75.0	81.3	3	5
4	F	53	R	0	MF	68	50	20	50	130	150	1	0	15.0	91.3	9	0
5	M	51	R	I	Sm	60	58	10	10	95	110	1	1	46.25	50.00	8	3
6	M	21	L	II	Sm	75		0	20	100	105	1	0	38.75	38.75	5	2
7	M	61	L	0	PLR, Sm	80	70	0	20	110	125	1	0	33.75	82.50	6	0
8	M	25	L	0	PLR, MF	80	45	0	10	100	125	1	0	42.5	70.0	6	1
9	F	18	L	0	LRef, Sm	80	42	10	30	100	145	1	0	75.0	87.5	7	1
10	F	38	L	0	LRef	70	51	15	45	120	135	1	0	53.75	93.75	6	0
11	M	22	R	II	PLR, MF	86	60	10	10	110	120	1	1	40.00	41.25	4	4
12	M	52	R	0	PLR, Sm	65	50	20	40	135	130	1	1	23.8	80.0	7	1
13	M	39	R	0	PLR, Sm	60	40	10	20	110	125	1	0	61.3	70.0	4	1
14	F	46	R	0	Sm	75	50	0	30	90	140	1	0	51.3	48.8	7	2
15	F	43	L	I	MF	88	54	−10	5	110	130	1	0	51.25	72.50	8	2
16	F	45	L	0	Sm	60	48	5	40	110	130	1	0	76.3	97.5	8	0
17	M	31	L	0	PLR, Sm	60	45	10	20	130	130	1	0	49.0	86.3	3	1
18	M	50	L	I	PLR, MF	89	62	0	20	110	130	1	0	35.00	72.50	7	0
19	F	67	L	0	PLR, Sm	58	54	0	30	110	130	1	0	38.75	80.00	9	0
20	M	42	L	0	PLR, Sm	100	74	0	20	100	120	1	0	62.50	96.25	1	0
21	M	34	R	II	PLR, MF	90	54	0	0	80	70	1	1	46.25	32.50	6	6
22	M	54	L	I	PLR, Sm	90	68	−20	10	95	105	1	0	30.00	78.75	5	1

NOTE. All patients had smoothing of the labrum by use of the ArthroCare device.

Abbreviations: Pre, preoperatively; Post, 6 months postoperatively; VAS, visual analog scale; PLR, partial labrum resection; Sm, smoothing of diffuse chondromalacia; MF, microfracturing and smoothing of delaminated acetabular cartilage; LRef, labrum refixation.