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Labral Reattachment in Femoroacetabular Impingement Surgery Results in Increased 10-year Survivorship Compared With Resection

Helen Anwander MD, Klaus A. Siebenrock MD, Moritz Tannast MD, Simon D. Steppacher MD

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Abstract

Background Since the importance of an intact labrum for normal hip function has been shown, labral reattachment has become the standard method for open or arthroscopic treatment of hips with femoroacetabular impingement (FAI). However, no long-term clinical results exist evaluating the effect of labral reattachment. A 2-year followup comparing open surgical treatment of FAI with labral resection versus reattachment was previously performed at our clinic. The goal of this study was to report a concise followup of these patients at a minimum of 10 years.

Questions/purposes We asked if patients undergoing surgical hip dislocation for the treatment of mixed-type FAI with labral reattachment compared with labral resection had (1) improved hip pain and function based on the Merle d'Aubigné-Postel score; and (2) improved survival at 10-year followup.

Methods Between June 1999 and July 2002, we performed surgical hip dislocation with femoral neck osteoplasty and acetabular rim trimming in 52 patients (60 hips) with mixed-type FAI. In the first 20 patients (25 hips) until June 2001, a torn labrum or a detached labrum in the area of acetabular rim resection was resected. In the next 32 patients (35 hips), reattachment of the labrum was performed. The same indications were used to perform both procedures during the periods in question. Of the 20 patients (25 hips) in the first group, 19 patients (95%) (24 hips [96%]) were available for clinical and/or radiographic followup at a minimum of 10 years (mean, 13 years; range, 12–14 years). Of the 32 patients (35 hips) in the second group, 29 patients (91%) (32 hips [91%]) were available for clinical and/or radiographic followup at a minimum of 10 years (mean, 12 years; range, 10–13 years). We used the anterior impingement test to assess pain. Function was assessed using the Merle d'Aubigné- Postel score and ROM. Survivorship calculation was performed using the method of Kaplan-Meier with failure defined as conversion to THA, progression of osteoarthritis (of one grade or more on the Tönnis score), and a Merle d'Aubigné-Postel score < 15.

Results At the 10-year followup, hip pain in hips with labral reattachment was slightly improved for the postoperative Merle d'Aubigné-Postel pain subscore (5.0 ± 1.0 [3–6] versus 3.9 ± 1.7 [0–6]; p = 0.017). No difference existed for the prevalence of hip pain assessed using the anterior impingement test with the numbers available (resection group 52% [11 of 21 hips] versus reattachment group 27% [eight of 30 hips]; odds ratio, 3.03; 95% confidence interval [CI], 0.93–9.83; p = 0.062). Function was slightly better in the reattachment group for the overall Merle d'Aubigné-Postel score (16.7 ± 1.5 [13–18] versus 15.3 ± 2.4 [9–18]; p = 0.028) and hip abduction (45° ±

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

H. Anwander, K. A. Siebenrock, M. Tannast, S. D. Steppacher (✉)
Department of Orthopaedic Surgery, Inselspital, Bern University Hospital, University of Bern, CH-3010 Bern, Switzerland
e-mail: simon.steppacher@insel.ch

13° [range, 30°–70°] versus 38° ± 8° [range, 25°–45°]; $p = 0.001$). Hips with labral reattachment showed a better survival rate at 10 years than did hips that underwent labral resection (78%; 95% CI, 64%–92% versus 46%, 95% CI, 26%–66%; $p = 0.009$) with the endpoints defined as conversion to THA, progression of osteoarthritis, and a Merle d'Aubigné-Postel score < 15. With isolated endpoints, survival at 10 years was increased for labral reattachment and the endpoint Merle d'Aubigné score < 15 (83%, 95% CI, 70%–97% versus 48%, 95% CI, 28%–69%; $p = 0.009$) but did not differ for progression of osteoarthritis (83%, 95% CI, 68%–97% versus 81%, 95% CI, 63%–98%; $p = 0.957$) or conversion to THA (94%, 95% CI, 86%–100% versus 87%, 95% CI, 74%–100%; $p = 0.366$).

Conclusions The current results suggest the importance of preserving the labrum and show that resection may put the hip at risk for early deterioration. At 10-year followup, hips with labral reattachment less frequently had a decreased Merle d'Aubigné score but no effect on progression of osteoarthritis or conversion to THA could be shown.

Level of Evidence Level III, therapeutic study.

Introduction

The importance of an intact labrum for normal hip function has been shown in cadaveric [10, 25, 30] and computer-simulated studies [9]. The main function is to seal the joint and create a hydrostatic synovial fluid film between the cartilage layers. This fluid film prevents direct cartilage-on-cartilage contact and results in a more homogenous load distribution in the joint [10]. Labral tears or partial resection negatively affect the sealing function resulting in impaired intraarticular fluid pressurization putting the joint at risk for deterioration [9, 30]. Labral reattachment or reconstruction has the potential to improve hip function to levels similar to the intact state of the labrum [10, 30]. However, in earlier surgical treatments of hips with femoroacetabular impingement (FAI), the labrum was often resected after acetabular rim trimming or in areas with labral damage.

Preservation of the labrum has increasingly been performed consistent with the growing evidence of the importance of the labrum. Reattachment or reconstruction of the labrum in hips after open or arthroscopic surgery for FAI has become the standard treatment. However, there is only limited clinical evidence about the beneficial effect of labral reattachment compared with resection. At short-term followup, improved hip pain was found in hips after arthroscopic surgical treatment of the labrum [5, 15–17, 29, 33]. At a 2-year followup, Espinosa et al. [8] could show improved hip pain and decreased radiographic signs of osteoarthritis in hips after surgical hip dislocation for hip-preserving surgery (acetabular rim trimming and femoral osteochondroplasty) with labral reattachment compared with labral resection. To date, no long-term clinical results exist evaluating the effect of labral reattachment.

The goal of this study was to report a concise followup at a minimum 10 years of a previously published patient series from our institution [8] comparing labral reattachment with labral resection in hips after open surgical treatment for FAI. We asked if patients undergoing surgical hip dislocation and surgical treatment of mixed-type FAI with labral reattachment compared with labral resection had (1) improved hip pain and function as measured by an anterior impingement test, ROM, and Merle d'Aubigné-Postel score; and (2) a superior survival rate at 10-year followup with the endpoints defined as conversion to THA, progression of osteoarthritis of one grade or more on the Tönnis score, and a Merle d'Aubigné-Postel score < 15.

Patients and Methods

We retrospectively reviewed the same subset of 52 patients (60 hips) who had undergone surgical hip dislocation and treatment of FAI comparing labral reattachment and resection with a 2-year followup [8] performed at our institution. The indication for surgical hip dislocation with femoral neck osteoplasty and acetabular rim trimming was symptomatic hips with mixed-type FAI. For the total of 149 procedures (141 patients) performed during this period of time, our exclusion criteria [8] eliminated hips with incomplete clinical or radiological documentation (48 hips in 48 patients), hips with an open growth plate (four hips in four patients), age at surgery of older than 40 years (29 hips in 29 patients), previous hip surgery (seven hips in seven patients), and one patient (one hip) participating in professional athletic activity. This resulted in a total of 52 patients (60 hips) for evaluation (Table 1). The procedures were performed between June 1999 and July 2002. In the first 20 patients (25 hips) until June 2001, a torn labrum or the detached labrum in the area of acetabular rim resection was resected (resection group). In the following 32 patients (35 hips), reattachment to the acetabular rim was performed for a torn labrum or a labrum detached from the rim (reattachment group). The same indications were used to perform both procedures during the periods in question; this was a sequential series with the labral resections being performed in the earlier part of the study period and the labral reattachments being performed in the latter portion of the study period.

Table 1. Demographic parameters of the two study groups

Parameters	Labral resection	Labral reattachment	p value
Number of patients (hips)	20 (25)	32 (35)	–
Age (years)	29 ± 7 (17–40)	29 ± 6 (20–38)	0.726
Sex (percentage male of all hips)*	76	63	0.784
Side (percentage right of all hips)†	72	49	0.067
Height (cm)	176 ± 11 (162–194)	174 ± 9 (157–195)	0.298
Weight (kg)	77 ± 15 (55–111)	73 ± 13 (45–103)	0.326
Body mass index (kg/m^2)	25 ± 4 (19–37)	24 ± 4 (19–32)	0.780
Type of FAI (percentage mixed-type)‡	100	100	0.870

Values of continuous parameters are expressed as mean ± SD with range in parentheses; * odds ratio of 1.26 (95% confidence interval [CI], 0.42–3.71); †odds ratio of 2.72 (95% CI, 0.91–8.15); ‡ odds ratio of 0.72 (95% CI, 0.01–37.4); FAI = femoroacetabular impingement.

Of the 20 patients (25 hips) in the first group, 19 patients (95%) (24 hips [96%]) were available for clinical and/or radiographic followup at a minimum of 10 years (mean, 13 years; range, 12–14 years). Of the 32 patients (35 hips) in the second group, 29 patients (91%) (32 hips [91%]) were available for clinical and/or radiographic followup at a minimum of 10 years (mean, 12 years; range, 10–13 years). Four patients (four hips) were not available for a minimum 10-year clinical and radiographic followup. One patient (one hip) in the resection group was lost to followup 2 years after surgery without progression of osteoarthritis or conversion to THA. He presented with a good clinical result (Merle d'Aubigné-Postel score of 18) at his last followup. Three patients (three hips) in the reattachment group were lost to followup between 2 and 6 years after surgery without progression of osteoarthritis or conversion to THA. They presented with a good clinical result (Merle d'Aubigné-Postel score ranging from 17 to 18) at their last followup. This resulted in a total of 48 patients (56 hips) for evaluation at a minimum 10-year followup.

The mean followup in the resection group was 13 years (range, 12–14 years) and 12 years (range, 10–13 years) in the reattachment group. We had complete clinical and radiographic followup in 42 patients (48 hips). The other six patients (eight hips) had a good clinical followup at a minimum of 10 years (Merle d'Aubigné-Postel score exceeding 15 points) and refused radiographic evaluation at 10-year followup. Those patients had radiographic evaluation between 2 and 6 years after surgery without progression of osteoarthritis. Therefore, these six patients (eight hips) were included in the survival analysis as survivors. The mean radiographic followup of the total of 52 patients (60 hips) with the last radiograph available was 9 years (range, 2–14 years).

The study was approved by the local institutional review board.

For the clinical and radiographic evaluation of the patients, the same assessment scheme from the previous report [8] was used. Clinical evaluation included the patient's history, anterior impingement test (pain in combined flexion and internal rotation, for this study defined as present or absent), and assessment of the full range of hip motion. As a clinical scoring system, the Merle d'Aubigné-Postel score [7] was assessed preoperatively and at 10-year followup. Different observers performed the clinical evaluation preoperatively and at the most recent followup. At followup, clinical evaluation was performed by one of us not involved in the surgical care of the patients (HA). Substantial inter- and intraobserver agreement has been reported for ROM [12, 20, 40], the anterior impingement test [19], and the Merle d'Aubigné-Postel score [7]. Radiographic evaluation consisted of an AP pelvic radiograph and a cross-table lateral view of the hip acquired in a standardized fashion [37] pre- and postoperatively. The radiographic morphology of the acetabulum and the proximal femur was evaluated using a validated and computerized method, which also allowed calculation of acetabular coverage (Table 2). Osteoarthritis was graded according to the classification of Tönnis [38]. These radiographic parameters were evaluated by one of us not involved in the surgical care of the patients (HA).

A detailed description of surgical hip dislocation has been previously published [11]. In short, the patient was positioned in the lateral decubitus position, the interval between the gluteus maximums and medius muscle (Gibson interval) was developed, and trochanteric osteotomy was performed. The anterior capsule was opened through a Z-shaped capsulotomy in the interval between the piriformis and the gluteus minimus muscle. The hip was subluxated, the ligamentum teres cut, the hip then completely luxated, and the ligamentum teres excised. With the femoral head and the acetabulum exposed, the labrum and the cartilage were inspected and graded according to Beck et al. [2]. A hemispheric plastic template was used to define the aspherical portion at the femoral head-neck junction, which subsequently was corrected. On the acetabular side, the labrum was surgically detached and the excessive part of the acetabular rim resected. In the first 20 patients, the

Table 2. Pre- and postoperative radiographic parameters of the two study groups (resection group including 25 hips in 20 patients and reattachment group including 35 hips in 32 patients)

Parameter	Preoperative			Postoperative		
	Resection group	Reattachment group	p value	Resection group	Reattachment group	p value
Lateral center-edge angle [39] (degrees)	33 ± 11 (12–54)	32 ± 9 (17–46)	0.768	30 ± 8 (11–41)	29 ± 8 (10–42)	0.619
Acetabular index [38] (degrees)	6 ± 7 (−2 to 17)	4 ± 6 (−9 to 17)	0.373	1 ± 5 (−8 to 10)	2 ± 5 (−9 to 16)	0.533
Extrusion index [22] (percent)	22 ± 11 (3–9)	20 ± 8 (6–35)	0.589	21 ± 8 (6–40)	22 ± 8 (6–40)	0.547
Crossover sign [32] (percent positive)	40*	49*	0.624	24†	14†	0.266
Caudocranial femoral coverage (percent)	77 ± 13 (52–100)	79 ± 9 (64–92)	0.527	77 ± 9 (53–90)	75 ± 9 (56–92)	0.624
Anterior coverage (percent)	23 ± 8 (9–31)	25 ± 7 (16–42)	0.493	23 ± 6 (10–32)	18 ± 7 (30–56)	0.029
Posterior coverage (percent)	38 ± 15 (15–68)	41 ± 7 (32–57)	0.565	39 ± 8 (20–52)	42 ± 7 (31–56)	0.234
Alpha angle in axial view [26] (degrees)	67 ± 9 (51–76)	70 ± 6 (59–82)	0.425	42 ± 6 (30–50)	43 ± 5 (33–51)	0.367
Osteoarthritis according to Tönnis classification [38]				–		–
Grade 0 (percent)	10 (40)	18 (51)	0.382			
Grade 1 (percent)	15 (60)	16 (46)	0.275			
Grade 2 (percent)	0	1 (3)	0.394			
Grade 3 (percent)	0	0	–			

Values of continuous parameters are expressed as mean ± SD with range in parentheses; * odds ratio of 0.71 (95% confidence interval [CI], 0.25–2.00); †odds ratio of 1.89 (95% CI, 0.51–7.08).

torn labrum or the detached labrum in the area of acetabular rim resection was resected. In the following 32 patients, the torn labrum or the detached labrum in the area of acetabular rim resection was reattached using two to six titanium bone anchors with nonabsorbable sutures (G II Titanium Anchor; DePuy, Mitek, Norwood, MA, USA) being passed through the base of the labrum and knots being placed on the outer surface. Only the ossified portion of degenerated labrum was resected. After verification of impingement-free ROM, the capsule and the wound were closed in layers and the greater trochanter was reattached using two to three 3.5-mm cortical screws.

The two study groups did not differ in 32 of 35 parameters describing demography (Table 1), the preoperative and postoperative radiographic morphology of the hip (Table 2), and the preoperative clinical status or the extent of intraoperative assessed cartilage and labral damage (Table 3). The two study groups differed in terms of preoperative flexion (Table 3), acetabular cartilage damage (Table 3), and postoperative anterior acetabular coverage (Table 2). In hips with labral resection, the preoperative flexion was decreased with a mean of 93° ± 12° (range, 70°–110°) versus 106° ± 12° (range, 70°–110°) in hips with labral reattachment ($p < 0.001$; Table 3). The percentage of cleavage lesions of the acetabular cartilage was increased in hips with labral resection compared with hips with reattachment (52% versus 24%; Table 3; p = 0.037) with a correspondingly decreased percentage of debonding lesions in hips with labral resection (Table 3). Postoperatively, the anterior acetabular coverage was increased in hips with labral resection with a mean coverage of 23% versus 19% in hips with labral reattachment (Table 2; p = 0.029).

At the 10-year followup, hip pain was compared using the prevalence of a positive anterior impingement test and the pain subscore of the Merle d'Aubigné-Postel score. Hip function was compared using the Merle d'Aubigné-Postel score and the full ROM. Survival rate at the 10-year followup was calculated with any of the following endpoints: conversion to THA, progression of osteoarthritis by at least one grade according to Tönnis, or a Merle d'Aubigné-Postel score of < 15 at most recent followup.

Normal distribution was tested using the Kolmogorov-Smirnov test. We compared demographic, clinical, radiographic, and surgery-related parameters between the two study groups using the independent Student's t-test for continuous data and the chi square test for binominal data. Survival rate was calculated according to the method of Kaplan-Meier [14] with the previously defined endpoints. Difference in survival at 10-year followup between the two study groups was tested using the log-rank test.

Results

At the 10-year followup, hip pain in hips with labral reattachment was slightly improved for the Merle d'Aubigné-

Table 3. Preoperative clinical parameters and intraoperative cartilage and labrum damage of the two study groups

Parameter (best-worst score possible)	Labral resection	Labral reattachment	p value
Number of patients (hips)	20 (25)	32 (35)	–
Merle d'Aubigné-Postel score [7] (18–0)	12.4 ± 1.9 (8–14)	12.6 ± 1.8 (5–16)	0.659
Pain (6–0)	1.4 ± 0.8 (0–2)	1.5 ± 0.9 (0–4)	0.682
Mobility (6–0)	5.4 ± 0.8 (4–6)	5.6 ± 0.6 (4–6)	0.136
Walking ability (6–0)	5.6 ± 0.7 (4–6)	5.5 ± 1.1 (1–6)	0.611
ROM			
Flexion (degrees)	93 ± 12 (70–110)	106 ± 12 (70–110)	< 0.001
Internal rotation (degrees)*	8 ± 18 (0–30)	15 ± 11 (0–30)	0.283
Anterior impingement test (percent positive)†	88	86	0.557
Femoral cartilage damage classified according to Beck et al. [2]			
Normal (percentage)	13 (52)	24 (68)	0.193
Malacia (percentage)	11 (44)	11 (32)	0.320
Debonding (percentage)	1 (4)	0	0.233
Cleavage (percentage)	0	0	–
Defect (percentage)	0	0	–
Acetabular cartilage damage classified according to Beck et al. [2]			
Normal (percentage)	1 (4)	0	0.233
Malacia (percentage)	4 (16)	9 (26)	0.368
Debonding (percentage)	2 (8)	13 (38)	0.010
Cleavage (percentage)	13 (52)	9 (26)	0.037
Defect (percentage)	5 (20)	4 (12)	0.359
Labral damage classified according to Beck et al. [2]			
Normal (percentage)	0	2 (6)	0.224
Degeneration (percentage)	6 (24)	9 (26)	0.880
Full-thickness tear (percentage)	9 (36)	15 (41)	0.593
Detachment (percentage)	1 (4)	2 (6)	0.764
Ossification (percentage)	9 (36)	7 (21)	0.167
Operation time (hours)	2.4 ± 0.6 (1.5–4.5)	2.5 ± 0.5 (1.5–4.0)	0.561

Values of continuous parameters are expressed as mean ± SD with range in parentheses; * internal rotation was analyzed with 90° flexion in the hip and knee; † odds ratio was 1.22 (95% confidence interval, 0.26–5.66).

Postel pain subscore (5.0 ± 1.0 [3–6] versus 3.9 ± 1.7 [0–6]; p = 0.017; Table 4). No difference existed for the prevalence of a positive anterior impingement test (resection group with 11 of 21 hips [52%] versus reattachment group with eight of 30 hips [27%], odds ratio, 3.03; 95% confidence interval [CI], 0.93–9.83; p = 0.062; Table 4). Hip function in hips with labral reattachment was slightly increased for the overall Merle d'Aubigné-Postel score (16.7 ± 1.5 [13–18] versus 15.3 ± 2.4 [9–18]; p = 0.028) and hip abduction (45° ± 13° [30°–70°] versus 38° ± 8° [25°–45°]; p = 0.001; Table 4). No difference existed for flexion, extension, internal rotation, external rotation, or adduction between hips with labral reattachment and resection (p ranging from 0.082 to 1.000; Table 4).

Hips with labral reattachment showed a better survival rate at 10 years (endpoints defined as conversion to THA, radiographic progression of osteoarthritis, or a Merle d'Aubginé score of < 15) than did hips that underwent labral resection (78%, 95% CI, 64%–92% versus 46%, 95% CI, 26%–66%; p = 0.009) (Fig. 1). In the group with labral reattachment, seven hips (20%) reached an endpoint including conversion to THA in two hips (6%), progression of osteoarthritis in five hips (14%), and a Merle d'Aubigné-Postel score of < 15 in five hips (14%). In the group with labral resection, 13 hips (52%) reached an endpoint including conversion to THA in three hips (12%), progression of osteoarthritis in four hips (16%), and a Merle d'Aubigné-Postel score of < 15 in 12 hips (48%). Survival at 10 years with single endpoints was as follows: for a Merle d'Aubigné score of < 15, mean survival was increased with labral reattachment (83%; 95% CI, 70%–97%) compared with labral resection (48%; 95% CI, 28%–69%; p = 0.009). No difference in survival with the endpoint as conversion to THA only was found between hips

Table 4. Clinical results at followup (including only hips with a minimum 10-year followup)

Parameters (best–worst score possible)	Resection group	Reattachment group	p value
Number of patients (hips)	17 (21)	28 (30)	–
Merle d'Aubigné-Postel score [7] (18–0)	15.3 ± 2.4 (9–18)	16.7 ± 1.5 (13–18)	0.028
Pain (6–0)	3.9 ± 1.7 (0–6)	5.0 ± 1.0 (3–6)	0.014
Mobility (6–0)	5.7 ± 0.7 (4–6)	5.8 ± 0.4 (5–6)	0.473
Walking Ability (6–0)	5.8 ± 0.4 (5–6)	5.9 ± 0.3 (5–6)	0.228
ROM			
Flexion (degrees)	99 ± 14 (70–120)	102 ± 11 (90–130)	0.388
Extension (degrees)	5 ± 3 (0–10)	5 ± 3 (0–10)	1.000
External rotation (degrees)	39 ± 26 (5–80)	36 ± 15 (10–75)	0.542
Internal rotation (degrees)	21 ± 13 (0–45)	20 ± 13 (0–45)	0.640
Abduction (degrees)	38 ± 8 (25–45)	45 ± 13 (30–70)	0.048
Adduction (degrees)	20 ± 8 (59–40)	22 ± 6 (15–30)	0.082
Anterior impingement test (percent positive)*	52	27	0.062

Values are mean ± SD with range in parentheses; *odds ratio of 3.03 with 95% confidence interval of 0.93–9.83.

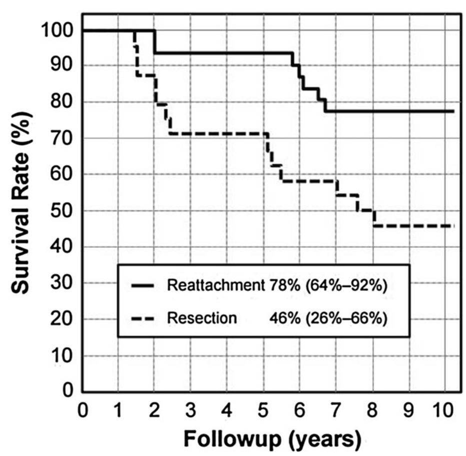

Fig. 1 Hips with labral reattachment (continuous line) showed an increased mean survival rate at 10 years of 78% (95% CI, 64%–92%) compared with hips with labral resection (broken line; mean survival rate of 46% [95% CI, 26%–66%; p = 0.009])

with labral reattachment (94%; 95% CI, 86%–100%) and resection (87%; 95% CI, 74%–100%; p = 0.366) and for the endpoint as progression of osteoarthritis only between hips with labral reattachment (83%; 95% CI, 68%–97%) and resection (81%; 95% CI, 63%–98%; p = 0.957).

Discussion

The importance of an intact labrum for normal hip function has been shown in cadaveric [10, 25, 30] and computer-simulated studies [9]. A beneficial effect on joint preservation and hip pain has been suggested at short-term clinical followup [8, 15, 16, 29, 33]. The aim of the current study was to evaluate hip pain, function, and survival of the joint at 10-year followup for labral reattachment in open surgical treatment of hips with FAI and compare with those hips with labral resection. Pain was slightly improved for hips with labral reattachment using the Merle d'Aubigné-Postel pain subscore but no difference was found for the prevalence of the anterior impingement test. Function was improved in hips with labral reattachment for the overall Merle d'Aubigné-Postel score and abduction, but this difference was clinically small (7° of abduction) and perhaps not important. Survival of hips treated with labral reattachment, with endpoints defined as conversion to THA, progression of osteoarthritis, or a poor clinical result (Merle d'Aubigné-Postel score < 15), was 78%; this was better than what we observed in hips after labral resection (46%; p = 0.009).

The study has several limitations. The main limitation is that the two study groups were not entirely comparable regarding the preoperative demographics (Table 1), radiographic parameters and surgical correction (Table 2), or clinical parameters and intraoperatively assessed cartilage/labral damage (Table 3). Three of 35 parameters were different including preoperative flexion, intraoperatively assessed cartilage damage, and postoperative anterior acetabular coverage. The increased prevalence of cleavage lesions of the acetabular cartilage in hips with labral resection (Table 3) could have decreased the survival rate in these hips. In addition, the decreased preoperative flexion in hips with labral resection (Table 3) could be the result of a more severe form of FAI; however, the radiographic morphology of the acetabulum and the proximal femur did not differ between the study groups (Table 2). These two factors potentially could have decreased survival in hips with labral resection; however, neither factor is a known negative predictive factor [34, 35] and a difference of 32% in survival at 10-year followup is very unlikely the exclusive result of these differences. The third parameter differing between the two study groups was the postoperative anterior acetabular coverage with a mean of 23% in hips with labral resection and 18% in hips with reattachment (Table 3). These values are both within the normal range of 19% ± 6% (range, 7%–29%) for anterior acetabular coverage [36] and should therefore not have influenced the results to a significant extent. An additional limitation is that the numbers of exclusion are relatively high with 89 hips (60%) excluded mainly as a result of incomplete documentation or an age exceeding 40 years at operation. The goal of the current study was to report an update of the original series previously published [8]. The high number excluded could have influenced our results and makes our findings only valid for patients younger than 40 years. However, most patients eligible for FAI surgery are younger than 40 years (up to 84% in long-term studies [34, 35]) because an age at operation exceeding 40 years is a known negative predictive factor [34]. Third, the numbers of patients and hips in both study groups were limited (25 and 35 hips in the resection and reattachment groups, respectively), which might have negatively affected power for calculating differences between the two study groups, eg, a prevalence of a positive anterior impingement test at followup of 52% in the resection group and 27% in the reattachment group (Table 4) was not significantly different (although with p = 0.062, there was a clear tendency).

There are additional limitations that need to be considered. The Merle d'Aubigné-Postel score is a relatively crude score for patients with FAI. Although we found an increased score in hips with labral reattachment at 10-year

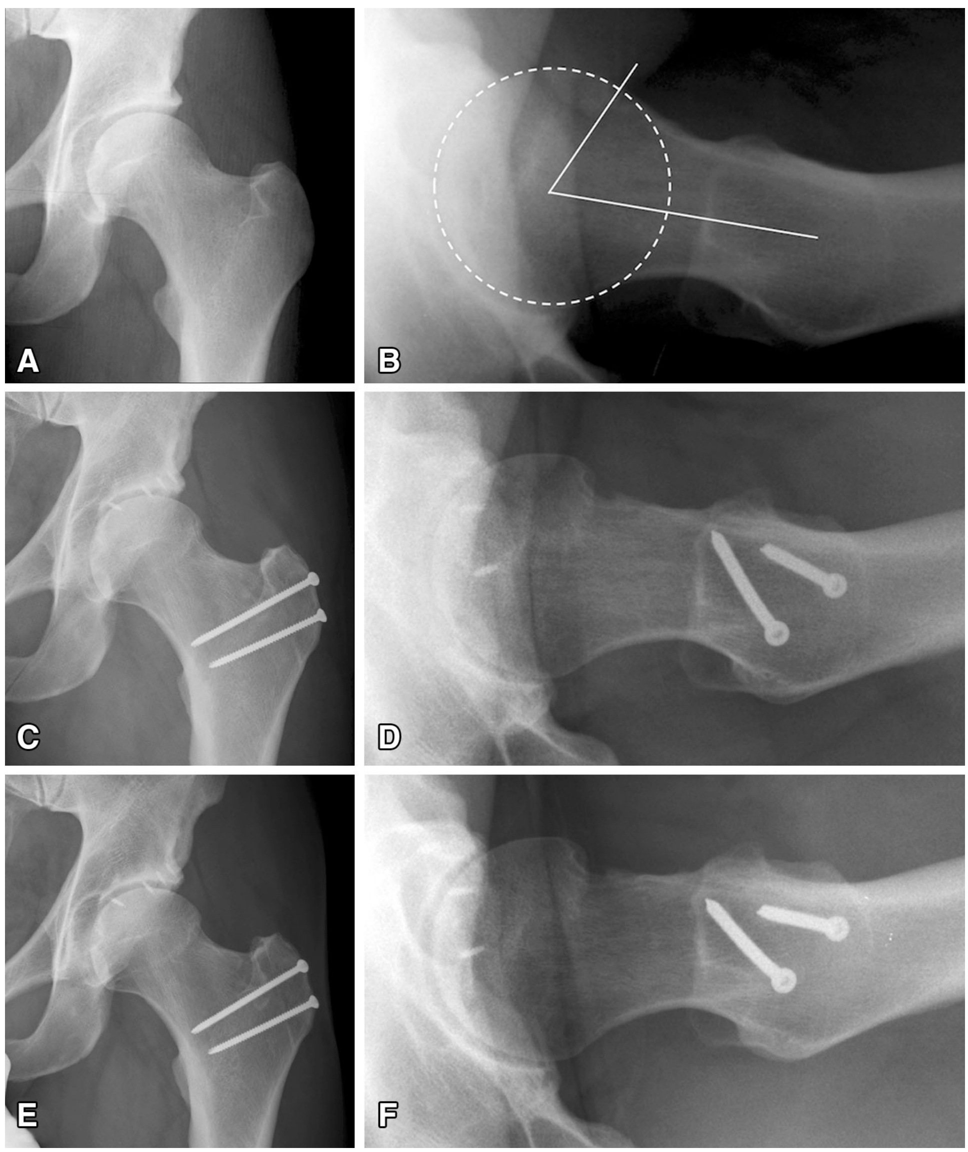

Fig. 2A–F (**A**) A 27-year-old male patient presented with mixed-type FAI, a Merle d'Aubigné-Postel score of 14, and radiologic osteoarthritis Grade 1 according to Tönnis. (**B**) The preoperative alpha angle was 63°. (**C**) He underwent surgical hip dislocation with acetabular rim trimming, reattachment of the labrum using four titanium bone anchors, and (**D**) osteochondroplasty of the neck. (**E**) At 11 years followup, the patient did not show progression of osteoarthritis (**F**) and had an excellent clinical result (Merle d'Aubigné-Postel score of 18).

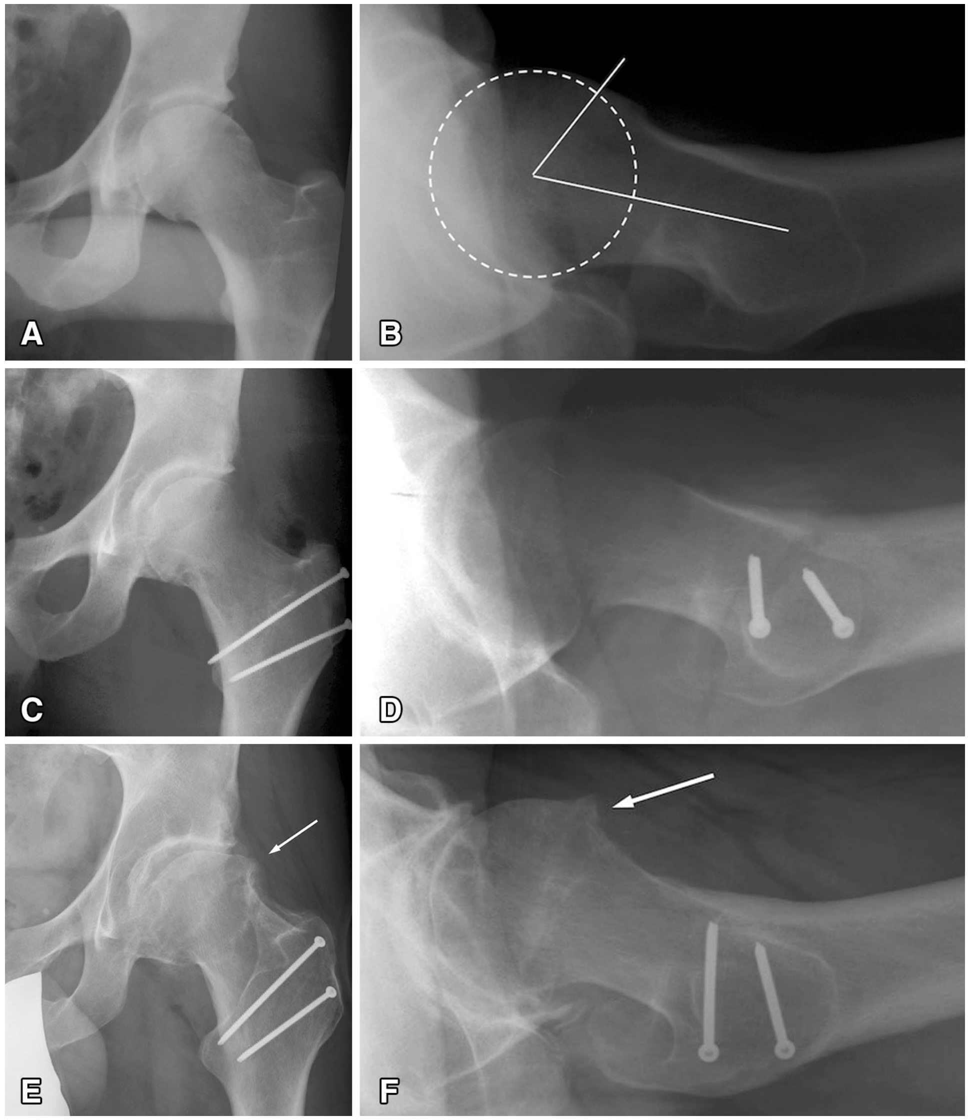

Fig. 3A–F (**A**) A 33-year-old male patient presented with mixed-type FAI, a Merle d'Aubigné-Postel score of 13, and radiologic osteoarthritis Grade 1 according to Tönnis. (**B**) The preoperative alpha angle was 60°. (**C**) He underwent surgical hip dislocation with trimming of the excessive part of the acetabular rim, resection of the labrum in the area of rim resection, and (**D**) osteochondroplasty of the neck. (**E**) At 5 years followup, the patient did show progression of osteoarthritis, increased pain, and impaired mobility and, therefore, (**F**) the hip had to be converted to THA at 5.5-year followup.

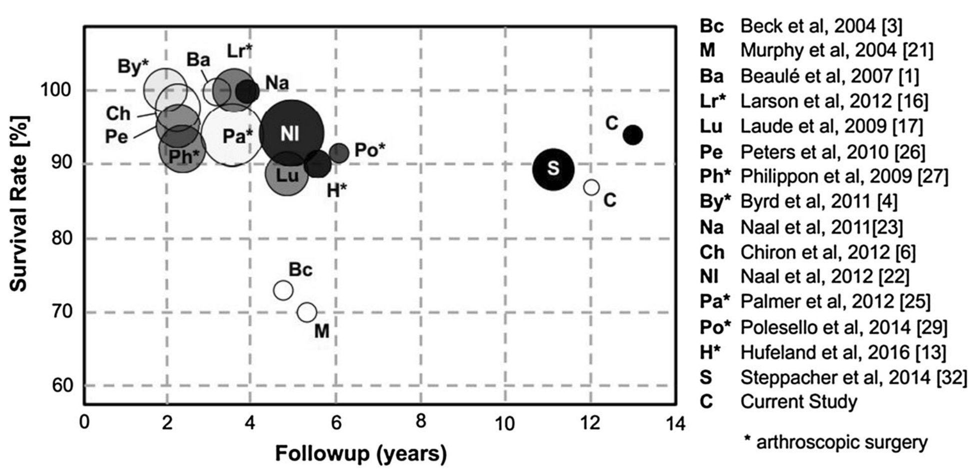

Fig. 4 Bubble chart showing followup, survival rate (with THA as the endpoint), size of the patient series (size of bubble), and the color-coded treatment of the labrum. Studies with 100% of labral reattachment are represented in black, labral resection in white, and percentage of labral reattachment in corresponding gray scales

Table 5. Selected studies comparing outcome after labrum reattachment and resection in surgical treatment for femoroacetabular impingement

Author (year)	Number of hips (patients)	Number of hips (patients) in reattachment/ resection group	Mean (range of) age at date of surgery (years)	Type of surgery	Mean (range of) followup (years)	Results
Espinosa et al. [8] (2006)	60 (52)	35 (32)/25 (20)	30 (20–40)	Surgical hip dislocation	2.0	Increased Merle d'Aubigné-Postel score and decreased Tönnis score in hips with reattachment at 2-year followup
Larson and Giveans [15] (2009)	75 (71)	39 (37)/36 (34)	Resection: 31 (16–57) Reattachment: 27 (16–56)	Arthroscopic	Resection: 1.8 (1–3) Reattachment: 1.4 (1–4)	Increased HHS in hips with reattachment at 1-year followup; no difference for SF-12 score or visual analog score for pain
Laude et al. [18] (2009)	97 (10)	(47)/(53)	33 (16–56)	Arthroscopic assisted miniopen	4.5 (2–9)	No difference in the nonarthritic hip score at last followup
Philippon et al. [29] (2009)	112 (112)	58 (58)/54 (54)	41 (38–44)	Arthroscopic	2.3 (2–3)	Labral reattachment was a predictor for increased postoperative modified HHS
Schilders et al. [33] (2011)	101 (96)	69/32	37 (15–71)	Arthroscopic	2.4 (2–4)	Increased modified HHS in hips with reattachment at a mean followup of 2.4 years
Larson et al. [16] (2012)	94 (90)	50 (48)/4 (42)	Resection: 32 (16–57) Reattachment: 28 (16–52)	Arthroscopic	3.5 (2–6)	Increased HHS, SF-12, and visual analog score for pain for reattachment at a mean of 3.5-year followup
Cetinkaya et al. [5] (2016)	73 (67)	34 (33)/39 (34)	33.5 (30–61)	Arthroscopic	3.8 (3-NA)	No difference in the daily hip outcome score at latest followup
Current study	60 (52)	35 (32)/25 (20)	30 (20–40)	Surgical hip dislocation	12.2 (10–14)	Superior survivorship in hips with labral reattachment with endpoints defined as conversion to THA, progression of osteoarthritis, or a Merle d'Aubigné-Postel score < 15

HHS = Harris hip score; NA = not applicable.

followup, the difference we observed was small, and may not be clinically important. Next, the impingement test only has fair agreement (intraclass correlation coefficient of 0.58 [range, 0.29–0.97; percent agreement of 91% [19]), which might have influenced our results because different observers recorded the impingement test preoperatively and at followup. In addition, the observer evaluating radiographs at followup (HA; one of us not involved in the surgical care of the patients) could not be blinded as a result of the use of metallic anchors for reattachment of the labrum that were clearly visible on the radiographs. An additional limitation is that not all patients could be followed up for at least 10 years with four patients (four hips) not available for minimum 10-year clinical and radiographic followup. These censored data could have affected the results for hip pain and function. It did not influence survivorship calculation because the statistical tests applied (Kaplan-Meier survivorship analysis, log-rank test) are specifically designed to take into account censored data.

We found a slight decrease in pain for hips with labral reattachment compared to hips with labral resection at the 10-year followup (Table 4). At the 2-year followup and in the same patient series, also a small difference in the Merle d'Aubigné Postel score with a mean of 17 [range, 13–18] with labral reattachment versus 15 [range, 10–18] in labral resection ($p = 0.01$) was found [8]. In the literature, contradictory results have been reported comparing labral resection and reattachment in surgical treatment of FAI (Table 5). No difference in hip function was found for arthroscopic [5] or miniopen treatment [17, 18] at a mean followup of 3.8 and 4.5 years, respectively. Others have found decreased pain and improved function in arthroscopically treated hips with labral reattachment at an early mean followup ranging from 1.4 to 3.5 years (Table 5) [15, 16, 27, 29, 30, 33].

The survival rate of hips with labral reattachment was 78% (Fig. 2) with the endpoints for failure defined as conversion to THA, progression of osteoarthritis, and a clinical result with a Merle d'Aubigné-Postel score of < 15 and increased compared to the 46% survival we observed in hips treated with labral resection (Fig. 3). This difference in survival can be attributed to the difference in the frequency of hips with a Merle d'Aubigne score of < 15 (survival with this endpoint only was 83% and 48% at 10 years for labral reattachment and resection, respectively). Survival with progression of osteoarthritis or conversion to THA as the endpoints showed no difference at 10 years between hips with labral reattachment or resection. The difference in survival based on endpoint chosen is the result of the evolution of joint degeneration, which usually starts with increasing pain followed by progression of osteoarthritis and possibly conversion to THA. Therefore, some patients with conversion to THA or progression of osteoarthritis failed earlier as a result of a Merle d'Aubigné score decreasing under 15 points. Considering THA as a single endpoint (for reason of comparability), survival was 94% with labral reattachment and 87% with resection at 10-year followup (Fig. 4). Comparing our results with noncomparative studies (and THA as the single endpoint), inferior mid- to long-term survival for hips with mainly labral resection compared with reattachment was found (Fig. 4; Table 5) [1, 3, 4, 6, 13, 16, 18, 21, 23, 24, 27–29, 31, 34].

In conclusion, we found that in hips with osteochondroplasty of the neck and acetabular rim resection including labral reattachment for the treatment of mixed-type FAI, survival as we defined it was 78% compared with 46% in hips with labral resection (Fig. 1). However, survival defined as conversion to THA or progression of osteoarthritis alone showed no difference at 10 years. The difference in overall survival was the result of the difference in the frequency of hips with a Merle d'Aubigné score of < 15. The main function of the labrum is to seal the joint and create a hydrostatic synovial fluid film to create a more homogenous load distribution, potentially increasing the durability of the joint [10, 25, 30]. This is the first study showing the clinical benefit of labral reattachment at a long-term followup in hips with open treatment for FAI. The current results suggest the importance of preserving the labrum and show that resection may put the hip at risk for early deterioration.

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