Shelf arthroplasties long-term outcome: Influence of labral tears. A prospective study at a minimal 16 years’ follow up

C. Berton\textsuperscript{a,b,*}, D. Bocquet\textsuperscript{a,b}, N. Krantz\textsuperscript{a,b}, A. Cotten\textsuperscript{a,c}, H. Migaud\textsuperscript{a,b}, J. Girard\textsuperscript{a,b}

\textsuperscript{a} Université Lille-Nord-de-France, 59000 Lille, France
\textsuperscript{b} Orthopaedic Surgery Department C, Roger Salengro Hospital, Lille University Hospital, 2, avenue Oscar-Lambret, 59037 Lille, France
\textsuperscript{c} Musculoskeletal Radiology Department, Roger Salengro Hospital, Lille University Hospital, 2, avenue Oscar-Lambret, 59000 Lille, France

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**KEYWORDS**
Hip dysplasia; Labral tears; Hip shelf arthroplasty; Osteoarthritis

**Summary**

Introduction: Osteoarthritis lesions extent and dysplasia severity (negative vertical center edge [CE] angle) are recognized as unfavorable criteria for the survival of shelf arthroplasties performed for correcting hip dysplasia. Labral tears have recently been described on dysplastic hips, indicating beginning osteoarthritis and worsening the risk of instability.

Hypothesis: The labral tears identified in the course of shelf arthroplasty procedures for correction of hip dysplasia carry a predictive value for the survival of this operation.

Objectives: Evaluate this hypothesis at the intermediate term in a long-term prospective observational study.

Patient and methods: Eighteen adult patients (18 dysplastic hips) having undergone shelf arthroplasty were included consecutively in a continuous prospective study. At the time the shelf arthroplasty was performed, a hip arthroscopic exam was carried out to search for and resect a labral tear if necessary. Fifteen patients were reviewed with a minimum follow-up of 16 years. Two patients died and one patient was lost to follow-up.

Results: During arthroscopic exploration, 10 hips presented labral tears (55.6%). At a mean follow-up of 16.3 years (range, 16–18 years), eight hips underwent hip arthroplasty. Of these hips, only one did not present a labral tear. The seven other hips had a tear of the labrum ($p < 0.001$). The overall survival rate was 41.3%; it was 83.3% for hips with no labral tear and 15.2% for hips with a lesion of the labrum ($p = 0.048$).

\* Corresponding author. Tel.: +33 3 20 44 68 28; fax: +33 3 20 44 66 05.
E-mail address: charles.berton@gmail.com (C. Berton).
Introduction

Proposed by Koenig in 1891 and published by Lance [1] in 1925, the hip shelf arthroplasty is the oldest means of correcting acetabular dysplasia. Kerboull [2] observed 85% good results with up to 13 years of follow-up. Rosset et al. [3] found a 90% survival rate at 15 years of follow-up. However, Judet [4] found disappointing results in cases of shelf arthroplasty with hip subluxation. Lemaire and Gillet [5] and Summers et al. [6] observed 50 and 71%, respectively, shelf procedure failures in cases of preexisting osteoarthritis. These data were confirmed by Migaud et al. [7]. To guarantee long-lasting results, it is now accepted and recommended to perform hip shelf arthroplasty in patients with a centered hip, positive-angle acetabulum (CE angle > 0°), and moderate osteoarthritis [4,7,8].

In hip dysplasia, the labrum is hypertrophied to compensate for bone coverage deficit and stabilize the femoral head [9]. Submitted to repeated stresses, the labrum is subject to developing tears whose frequency varied from 30 [10] to 87% [11]. The influence of labral tears on the result of acetabulum enlarging surgery (Chiari osteotomy, hip shelf arthroplasty) in hip dysplasias is controversial [12,13,14]. The objective of this study was to determine whether the existence of a labral tear, as well as negative CE angle or preoperative osteoarthritis, has a long-term negative predictive value on the result of hip shelf arthroplasty.

Patient and methods

Population

Eighteen adult patients (18 dysplastic hips) presenting an indication for hip shelf arthroplasty [8] were included continuously between April 1991 and May 1993 in a prospective study. The inclusion criteria were adult age (over 18 years of age), dysplastic hip with lateral bone coverage defect of the acetabulum (CE angle < 20°), positive-angle acetabular dysplasia (CE angle > 0°), hip centered with regard to the Shenton line (arc drawn from medial femoral neck through the superior margin of the obturator foramen). The patients’ mean age was 34 years ± 8.5 (range, 20–49 years) for a mean body mass index (BMI) of 24.5 kg/m² (range, 19.1–31.5). The study included 12 right hips and six left hips.

Discussion and conclusion: Labral tears had a negative impact on the outcome of shelf arthroplasty for hip dysplasia. This lesion therefore warrants being sought using appropriate exploration techniques (MRI or CT-arthrography) before shelf arthroplasty surgery. The existence of a preoperative labral tear does not seem to cast doubt on shelf arthroplasty itself. However, it should be identified so as to set objectives and expectations: long-term survival is significantly lower in the presence of a labral tear. It seems preferable to repair this type of lesion with arthroscopic guidance during shelf arthroplasty to prevent a potential source of residual pain, keeping in mind that secondary resection will be more difficult after covering the lesion.

Level of evidence: Level 3 prospective observational prognostic study.

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Analysis

Preoperative analysis

Preoperatively, all patients underwent morphological analysis with plain x-rays and CT-arthrography. The radiographic evaluation included an AP view of the pelvis [15–17] and a lateral X-ray (false profile view) of the dysplastic hip as described by Lequesne and Seze [18]. These images provided the basis for the coxometric workup and to assess the degree of osteoarthritis.

These measurements made it possible to evaluate acetabular dysplasia with the lateral vertical center edge (CE angle) [19,20], the vertical center anterior coverage angle (CA angle) [18,21], the roof angle with respect to the horizontal line named HTE [22], the acetabular coverage angle using the Sharp angle [23,24], and the Wagner coverage index [25]. Hip centering was evaluated with the Shenton line. Femoral dysplasia was measured with the head-shaft angle (caput-collum-diaphyseal angle [CCD]). Two observers conducted the analysis (a radiologist specialized in osteoarticular pathology and an orthopaedic surgeon). All the hips presented positive-angle acetabular dysplasia with an external coverage defect (0 < CE angle < 20°). In seven of the 18 cases, there was femoral dysplasia associated with coxa valga (CCD > 140°) (Table 1).

Surgical method and intraoperative analysis

A Smith-Petersen approach [27] exposing the joint capsule was systematically used. A dual-approach (lateral and anterolateral) hip arthroscopy was carried out in the same surgical procedure. Distraction was fluoroscopically confirmed. The entire acetabular labrum was explored in four zones (anterosuperior, anteroinferior, posterosuperior, and posteroinferior). The location and type (fibrillated, flap, peripheral longitudinal fissure, bucket handle, unstable labrum, horizontal split) of any labral tears were noted [28] (Fig. 1). The free portion of the labral tear was then systematically excised under arthroscopic guidance. Finally, shelf arthroplasty was performed following the Roy-Camille shelf arthroplasty technique [29] (Fig. 2).

Analysis at follow-up

The patients were analyzed clinically using the Postel-Merle d’Aubigné (PMA) score [30]. The need for surgical revision
Table 1  Values of the radiographic measurement criteria of femoral and acetabular dysplasia and their normal values.

<table>
<thead>
<tr>
<th></th>
<th>Normal values</th>
<th>Values measured in this series</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE angle [19,20]</td>
<td>&gt; 25°</td>
<td>10.6 (2—19)</td>
</tr>
<tr>
<td>CA angle [18,21]</td>
<td>≥ 25°</td>
<td>11.3 (5—22)</td>
</tr>
<tr>
<td>HTE angle [22]</td>
<td>≤ 10°</td>
<td>22.1 (13—36)</td>
</tr>
<tr>
<td>Sharp angle [23,24]</td>
<td>≤ 43°</td>
<td>47.6 (40—53)</td>
</tr>
<tr>
<td>Wagner Index [25]</td>
<td>≥ 80%</td>
<td>60.4 (45.2—76)</td>
</tr>
<tr>
<td>CCD angle</td>
<td>120—140°</td>
<td>138 (125—155)</td>
</tr>
</tbody>
</table>

for conversion to total hip arthroplasty was determined for each patient. Statistical analysis was done using XLStat™. The continuous variables were analyzed with simple logistic regression and ANOVA. Nonparametric tests (Mann-Whitney, Wilcoxon, F-test, or log-rank) were carried out on small samples. The alpha risk was set at 5%. The survival analyses were established using the Kaplan-Meier method, considering conversion to total hip arthroplasty (THA) because of osteoarthritis as the endpoint. The 95% confidence intervals were detailed for the survival analyses. The log-rank test was used to compare survival curves.

Figure 1  Suspected disinsertion of labrum on CT-arthrography confirmed by arthroscopic exploration.

Figure 2  Shelf procedure performed on positive CE angle hip dysplasia in a 35-year-old woodcutter. The fissure-type labral tear (arrow) was arthroscopically resected during the shelf procedure. Postoperative shelf arthroplasty (arrows) and at 15 years of follow-up (arrows) just before revision with total hip arthroplasty for symptomatic progressive osteoarthritis.
Results

One patient was lost to follow-up and two others died during the follow-up period, unrelated to the intervention: one died of cardiac causes 5 years after surgery with no conversion to THA; the other died 4 years after surgery of generalized breast cancer (conversion to THA had been necessary following fracture of the ipsilateral femur neck related to bone metastases). This patient was excluded from the survival analysis. All the other patients were seen in 2009 with a minimum follow-up of 16 years (mean, 16.3 years; range, 16–18 years).

At the time shelf arthroplasty was performed, during arthroscopic exploration, 10 hips presented labral tears (55.6%), located for the most part in the superior part of the labrum (70%): three fibrillated lesions, two flaps, and five bucket-handle lesions.

The head-shaft angle was the only predictive element for labral tear: the CCD angle was significantly greater in the group with lesions in the labrum (p < 0.05) (Table 2).

Table 2 Predictive factors of labral tear.

| CE angle [19,20] | Labrum − 11.4° (7–19) | Labrum + 9.3° (2–19) | p = 0.347 |
| CA angle [18,21] | Labrum − 13.1° (6–22) | Labrum + 9.8° (5–22) | p = 0.207 |
| HTE angle [22] | Labrum − 19° (13–32) | Labrum + 24.6° (10–32) | p = 0.179 |
| Sharp angle [23,24] | Labrum − 46.5° (40–53) | Labrum + 48.4° (43–53) | p = 0.446 |
| Wagner index [25] | Labrum − 62.3° (51.4–74) | Labrum + 58.9° (43.1–76) | p = 0.446 |
| CCD angle | Labrum − 134.3° (125–145) | Labrum + 140.6° (134–155) | p = 0.039 |

Labrum −: no labral tear.
Labrum +: labral tear.

The Shenton line was systematically respected. Six hips presented no signs of preoperative osteoarthritis (Table 3). There was no statistically significant difference concerning the presence of preoperative osteoarthritis and the existence of a labral tear (p = 0.706).

The value of CT-arthrography in the diagnosis of the labral tears was excellent (Table 4, Figs. 1 and 2). The results of CT-arthrography were similar to the arthroscopic observations in 16 of 18 cases (89%). CT-arthrography had a 90% positive predictive value (range, 70–100) and an 87.5% negative predictive value (range, 65–100).

At the last follow-up, eight hips had been converted to THA: one hip presented no labral tear at the time of the index procedure and seven had a lesion in the labrum (p < 0.001). The indication for conversion to THA was the recurrence of groin pain associated with joint space narrowing in all cases. Conversion to THA for painful coxarthrosis was performed a mean 11.5 years (range, 5–17 years) after the shelf arthroplasty.

The PMA score of the eight patients who underwent THA was always less than 12 out of 18 before prosthesis implantation. In seven patients out of 10 who did not undergo revision and were seen at the last follow-up (not lost to follow-up or deceased), the PMA score was considered excellent in two cases, very good in one case, good in three cases, and mediocre in one case: a female patient who initially had not presented a labral tear.

The survival rate at 18 years, with the endpoint implantation of a total hip prosthesis for painful coxarthrosis, was 41.3% (95% CI, 26.8–55.8%) (Fig. 3).

For the hips that did not have labral tear when shelf arthroplasty was performed, the 18-year survival rate was 83.3% (95% CI, 68.1–98.5%). For the hips that had labral tear, the survival rate was 15.2% (95% CI, 2–28.8%). The difference in survival in the two populations was significant (p = 0.048) (Fig. 4).

Discussion

In comparison with Bernese-type acetabular osteotomies [31–34], acetabulum-enlarging surgery, notably hip osteo-plastic shelf arthroplasty, does not cover the femoral head with hyalin cartilage. However, it gives good functional results [35,36]. Chiron et al. [35] found up to 75% of their patients totally asymptomatic at a mean follow-up of 4.6 years after minimally invasive shelf arthroplasty via the anterior approach. Several studies investigating the long-term results of hip shelf arthroplasty report highly
encouraging survival rates [3,6–8,37–39]. In a retrospective study of a series of 57 patients (65 hips) and a long follow-up period (over 16 years), Migaud et al. [7,8] reported a satisfactory result in 50% of patients with more than 20 years of follow-up. The survival rate was 80% at 10 years, 60% at 15 years, and 40% at 21 years. These rates are close to those announced by Steppacher et al. [34] after Bernese osteotomy, with 77% survival at 15 years and 60% at 20 years. In the present series, we found comparable results with an accumulated 82.5% survival rate at 10 years, 61.9% at 16 years, and 41.3% at 18 years (Fig. 3).

It has been proved that arthroscopic procedures before hip shelf arthroplasty provided inferior functional results and lower survival rates [3–8,39]. Migaud et al. [8] found an 83% 18-year survival rate when osteoarthritis was moderate (grade 2) and 27% when osteoarthritis was severe (grades 3 and 4). In addition, shelf arthroplasty provided less satisfactory results when it was performed on hips with negative CE angle dysplasia (CE < 0°) [3,8]. Finally, Judet [4] found disappointing results in cases of shelf arthroplasty with hip subluxation. The present study showed that labral tears occurring before the shelf arthroplasty were also a negative prognostic factor in terms of long-term survival. However, the impact of labral tears on the outcome of hip shelf arthroplasty is controversial. On the one hand, Nishina et al. [12] observed that the existence of a labral tear increased the risk of acetabulum enlargement surgery failure with Chiari pelvic osteotomy. Nevertheless, this was a retrospective study on positive and negative VCE angle dysplasia, with the labral lesion diagnosis based solely on CT-arthrography, with no arthroscopic control. On the other hand, Girard et al. [13] observed no impact of labral tears on acetabulum enlargement surgeries. This was a prospective study with arthroscopic diagnosis of the labrum lesions, but the series grouped Chiari osteotomies (if CE angle < 0°) and hip shelf arthroplasties (if CE angle > 0°) indifferently. In the present study, a relation was observed between the existence of a preexisting labral tear and long-term survival. A labral tear probably impacted the shelf arthroplasties and the Chiari pelvic osteotomies differently. The transformation of the weight-bearing zone of the labral tear and the modification of Pauwels balance created by the Chiari osteotomy probably reduced the clinical repercussions of the labral tear. Like preexisting osteoarthritis [8], a lesion in the labrum associated with a dysplastic hip seems to have a more unfavorable clinical prognosis for shelf arthroplasty than for Chiari pelvic osteotomy.

The diagnosis of labral tear is classically suspected upon clinical examination and confirmed during joint exploration. Klaue et al. [10] described the clinical signs of acetabular rim syndrome, which suggest a labral lesion diagnosis. However, Girard et al. [13] found no correlation between these signs and the presence of labral tear, confirmed by arthroscopy. According to these authors, there are no specific signs of labral tear. CT-arthrography is a useful

| Table 4 | Evaluation of CT-arthrography effectiveness in diagnosis of acetabular labral tears in positive VCE angle dysplastic hips. |
|-----------------|-----------------|-----------------|
|                 | Value           | Lower limit (95%) | Upper limit (95%) |
| Sensitivity     | 0.900           | 0.571            | 1.000            |
| Specificity     | 0.875           | 0.505            | 0.995            |
| Positive predicative value | 0.900 | 0.714           | 1.000            |
| Negative predicative value | 0.875 | 0.646           | 1.000            |
means for diagnosing this because it provides an immedi-
ate response after injection of local anesthetic products and
shows labral lesions with 88% sensitivity [40]. In our study,
CT-arthrography demonstrated excellent sensitivity (90%) in
detecting lesions of the labrum. Magnetic resonance imaging
(MRI) of the hip, a noninvasive method, can identify labrum
lesions with the same precision as arthro-MRI [41,42]. Mintz
et al. [41] found 95% sensitivity in detecting labrum injuries
with MRI.

To our knowledge, there is no consensus on the therapeu-
tic course of action to take with dysplastic hip labral tears.
In the present series, we observed less favorable clinical
results in patients who had undergone hip shelf arthro-
plasty with systematic repair of the associated labral lesion.
In contrast, Nishina et al. [12] found unfavorable clinical
results, with 50% clinical failure, in their patients oper-
ated on with Chiari osteotomy without associated labrum
repair. Similarly, Yamamoto et al. noted that arthroscopic
repair of the labral tear improved the clinical symptoms
[43]. However, in our series, the loss of congruence between
the femoral head and the acetabulum induced by labral
resection resulted in poor clinical results that were proba-
bly secondary to arthritic deterioration. Dorrel and Catteral
suggested an alternative to prevent this deterioration: peri-
acetabular osteotomy concurrent with labral resection [44].
These two actions combined seem to control the reemer-
gence of pain and osteoarthritic progression [13].

Conclusion

Osteoarthritis, negative-angle acetabular dysplasia, and
subluxation are known factors of failure of hip shelf arthro-
plasty. This prospective, homogenous study with a minimum
follow-up of 16 years suggests that survival of hip shelf
arthroplasty (with positive-angle acetabular dysplasia) is
significantly less satisfactory in cases of labral tears.

It seems mandatory to systematically search for labral
tears before performing hip shelf arthroplasty. The pre-
operative paraclinical workup should include not only plain
X-rays (evaluation of hip centering, dysplasia, and
coxarthrosis), but also a CT-arthrography or MRI, if possi-
bly completed by hip arthroscopy to explore the acetabular
labrum.

The existence of a preoperative labral tear does not seem
to contest shelf arthroplasty surgery. However, a labral tear
should be known so as to set the objectives and expectations
of the shelf arthroplasty.

Conflict of interest statement

None.

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