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Original Research Article

Outcomes of Hip Shelf Procedure in Treating Legg-Calvé-Perthes Disease

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Abstract: ***Introduction***: Legg-Calvé-Perthes disease (LCPD) is a pediatric ischemic condition of the femoral head leading to necrosis. This study evaluates the hip shelf procedure's effectiveness in treating LCPD and the resulting clinical outcomes. ***Methods***: A retrospective analysis of 17 patients treated with the hip shelf procedure at the Pediatric Orthopedics and Traumatology Department of CHU Hassan II, Fes, over ten years. Data on patient demographics, clinical presentations, radiological assessments, and surgical outcomes were analyzed. ***Results***: The average age at consultation was 9 years, with a male predominance (88.2%). Radiological staging showed most patients in the fragmentation or reconstruction stages. Post-operative results indicated significant improvement in hip joint stability and remodeling. ***Conclusion***: The hip shelf procedure is effective in managing LCPD, promoting favorable hip joint remodeling and function in pediatric patients. Early intervention is crucial for optimal outcomes.

Keywords: Femoral Head, Radiological Staging, Hip Shelf Procedure, Prognostic Classification.

Abbreviation: LCPD, CHU, AP, MRI, CT

INTRODUCTION

Legg-Calvé-Perthes disease (LCPD) is an idiopathic condition characterized by avascular necrosis of the femoral head in children. It progresses through stages of necrosis, fragmentation, ossification, and remodeling. The primary treatment goal is to preserve the femoral head's sphericity and prevent deformities. This study aims to evaluate the efficacy of the hip shelf procedure in managing LCPD, focusing on epidemiological, diagnostic, and therapeutic aspects.

METHODS

This retrospective study was conducted on patients treated from January 2009 to December 2019 at CHU Hassan II, Fes. Seventeen patients diagnosed with LCPD and treated with the hip shelf procedure were included. The inclusion criteria consisted of a confirmed diagnosis of LCPD and surgical intervention using the hip shelf procedure. Data were obtained from medical records, including age, gender, clinical presentation, radiological findings (Waldenström and Herring classifications), and surgical outcomes. Post-operative follow-ups assessed hip joint function and remodeling. Descriptive statistics were used to summarize patient demographics, clinical presentations, and surgical outcomes.

RESULTS

Age: At the time of consultation, the average age was 9 years, ranging from 6 to 13 years. The average age

at the onset of symptoms was 6 years, with extremes ranging from 2 to 12.5 years.

Gender: Among the 17 patients, 15 were boys and 2 were girls, representing 88.2% and 11.8% of cases respectively. The sex ratio was 7.5 boys for every girl.

Affected Side: Of the 17 patients, 8 had right-side involvement (47%), 7 had left-side involvement (41%), and 2 had bilateral involvement (12%).

Reason for Consultation: The majority of patients (94%) consulted for painless limping. One patient (6%) presented with mechanical pain without limping.

Physical Signs: Twelve patients reported hip pain of mechanical origin, while 4 patients presented with pain in both the hip and knee. One patient complained solely of knee pain. Limitation of hip movement was observed in 15 children: 9 had limited abduction, 3 had limited external rotation, 2 had limited internal rotation, and 1 had limited adduction. Additionally, thigh atrophy was noted in 6 patients.

Imaging: All patients underwent standard pelvis radiography. According to the Waldenström classification, 5 cases were at the fragmentation stage (29%), 7 at the reconstruction stage (42%), and 5 at the sequelae stage (29%). According to the Herring classification, 2 patients (12%) were at stage A, 3 patients (17%) at stage B, 5 patients (30%) at stage B/C, and 7 patients (41%) at stage C. Five patients had knee radiographs, and three patients had CT scans. No patients underwent scintigraphy or MRI.

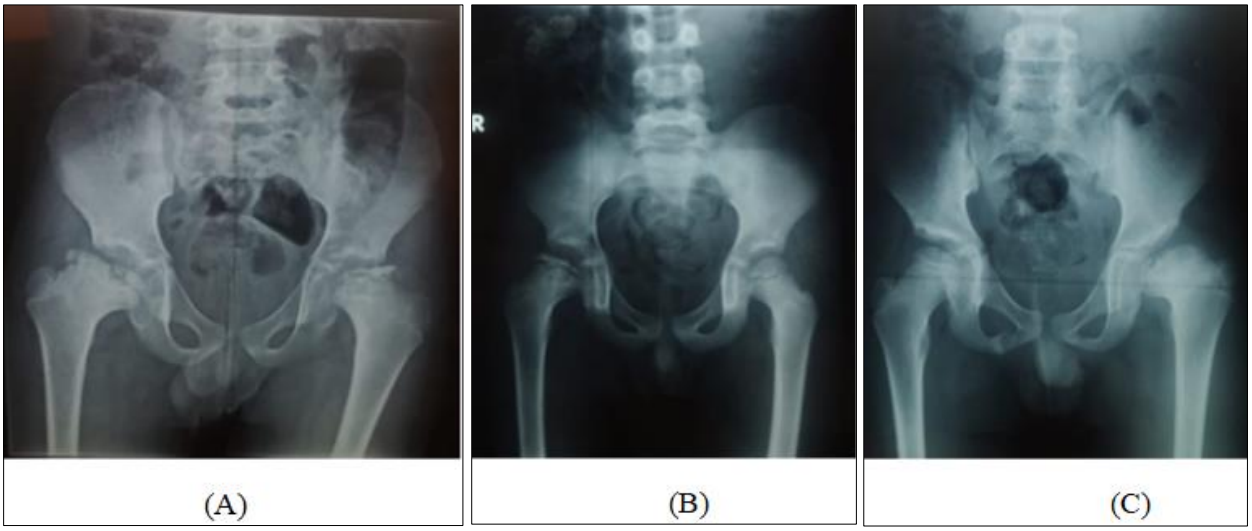

Figure 1: Standard anteroposterior (AP) pelvis radiograph shows the stages of fragmentation (A), reconstruction (B), and sequelae (C)

Treatment Strategy:

The most common indications for the hip shelf procedure in treating LCPD included severe forms of the disease with an age over 8 years and early deformities of the femoral head (11 patients), as well as subluxation and insufficient coverage of the femoral head (6 patients).

Surgical Technique:

The Salmon technique was used for all patients. This involved a Smith-Peterson incision, identifying and retracting the direct tendon of the rectus femoris, and placing a cortico-cancellous graft at the level of the supra-acetabular osteotomy. Immediate post-operative care included a Bermuda-type cast for one month, followed by weight-bearing with crutches upon cast removal, and full weight-bearing at two months.

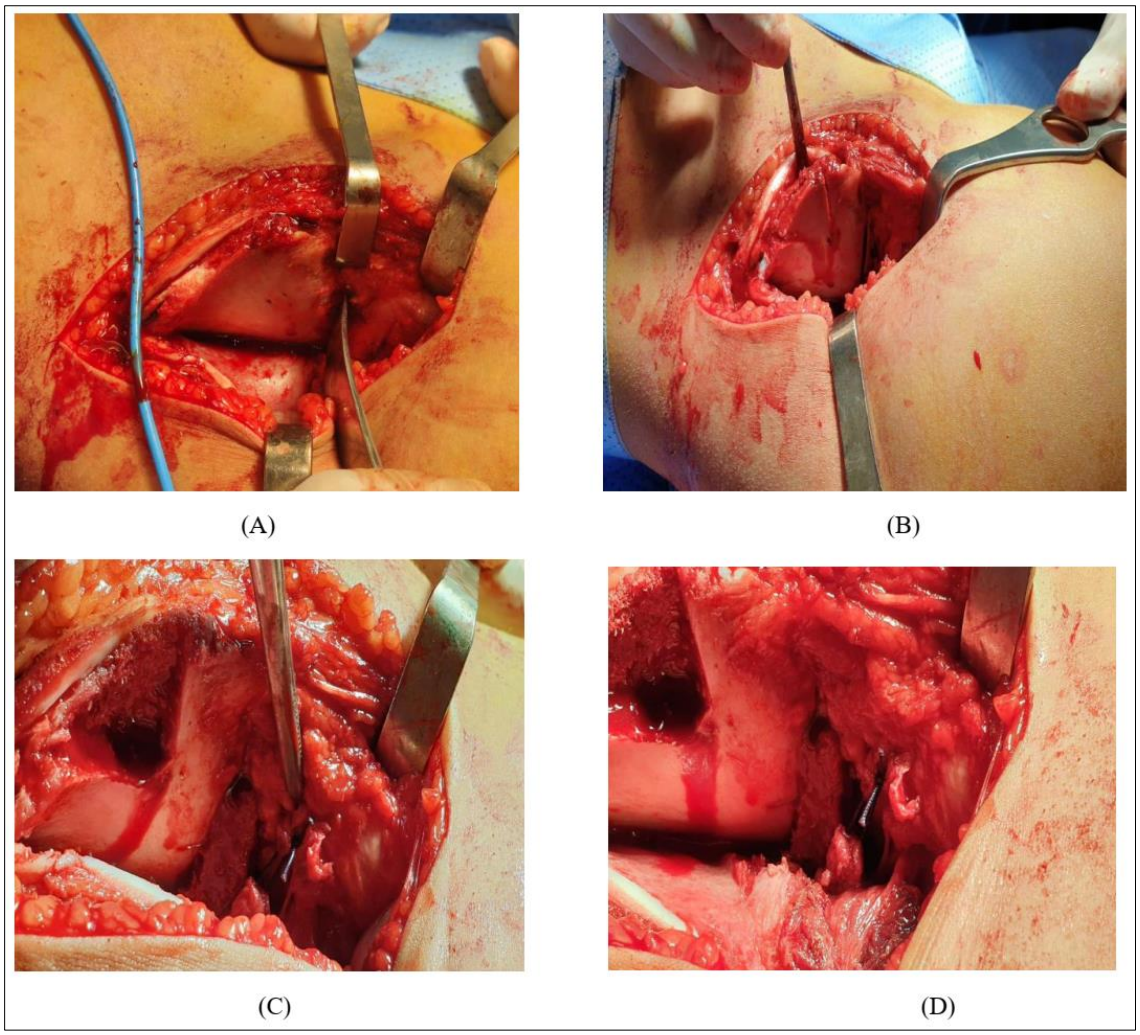

Figure 2: Trenching approximately 5 mm in height and 2 cm in depth using a curved bone chisel (A), Creating ananchoring groove for the stop (B), Harvesting a corticocancellous graft from the outer cortex (C), Placing the graft in the trench and securing the reflected tendon with resorbable sutures (D)

Follow-Up Schedule:

Patients were monitored both clinically and radiologically, with immediate post-operative radiographs, radiographs at cast removal, at 2 months, 3 months, and then at 6 months. Clinical monitoring included evaluating hip mobility and pain, while radiological monitoring, assessed using the Herring prognostic classification, tracked disease progression, assessed outcomes, and detected complications.

Complications:

No infectious complications were reported. However, three patients experienced hip stiffness. Graft resorption was not observed, and insufficient coverage of the femoral head was noted in three patients.

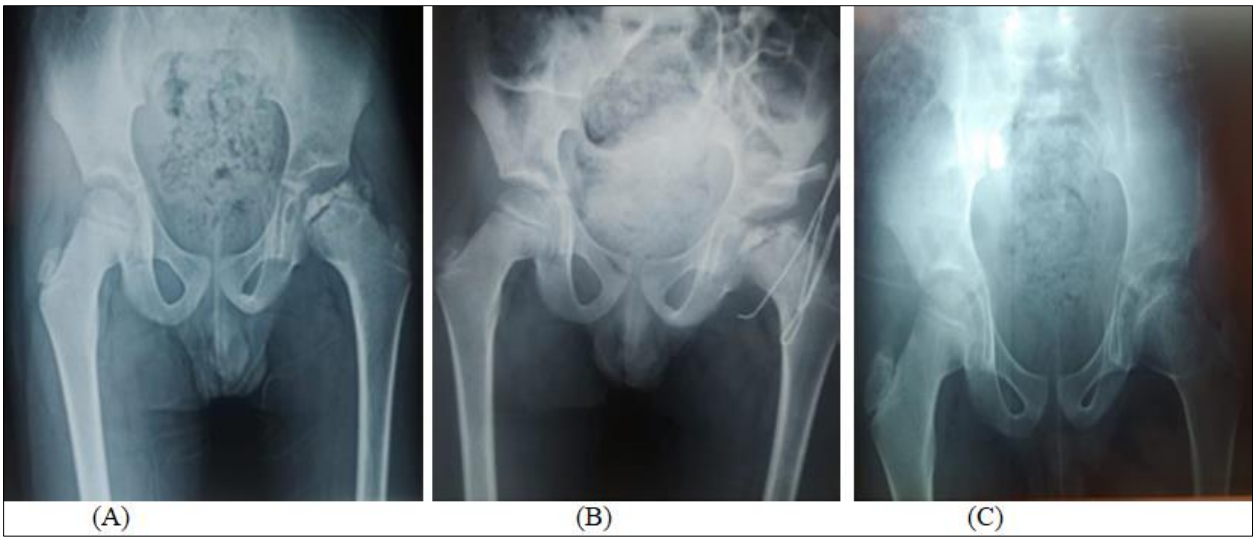

Figure 3: Standard pelvic radiograph with left Osteochondritis at the reconstruction stage (A), after hip shelf procedure (B), after 4 years of follow-up (C)

DISCUSSION

In 1883, Thomas described a hip condition resembling an infection that healed spontaneously without surgery. In 1909, Arthur Legg discussed an obscure hip ailment, suggesting that secondary hyper pressure from trauma could lead to flattening of the femoral head, presenting five cases. In 1910, Perthes reported six cases he called "juvenile deforming arthritis," thinking it was an inflammatory condition, while Calvé described ten cases of a "non-inflammatory, self-limiting condition" that healed with flattening of the weight-bearing surface of the femoral head. Waldenström considered the possibility of tuberculosis. In 1913, Perthes described the pathological anatomy of a femoral head from a nine-year-old child. By 1920, Waldenström termed the disease "coxa plana," and Sundt published a monograph reporting 66 cases. In 1926, Kontjetzny identified vascular obstruction with thickened cartilage in an anatomical specimen [1].

Clinically and epidemiologically, over a ten-year period, 17 children with LCP were recorded, averaging 1.7 cases per year. Literature estimates the disease's incidence at 0.3 to 1 per 1000. In our series, there was a marked male predominance (88.2%), aligning with other studies showing a 5-6:1 male-to-female ratio. Diagnoses in our study ranged from ages 6 to 13, with a mean age of 9, while literature notes onset between 3 and 13 years, peaking between ages 4 and 8. Bilateral cases comprised 12% of our patients. Typically, the initial symptom is a limp, often subtle and appearing with exertion, disappearing with rest. In our series, 90% experienced painful limping [2-5].

Radiologically, standard X-rays remain crucial for initial diagnosis and monitoring. Early signs include reduced height or flattening of the epiphyseal nucleus, leading to a pseudo-widened joint space and a "crescent sign." As the disease progresses, radiographs reveal stages of condensation, fragmentation, reconstruction, and remodeling. Prognostic classifications are largely based on conventional X-rays. Bone scintigraphy, which was not used in our patients, assesses epiphyseal vascularity by tracking a technetium-99m tracer [6]. MRI, however, is the preferred method for early diagnosis, detecting changes before they appear on X-rays and providing excellent visualization of cartilage and femoral head morphology. It identifies four zones in the femoral epiphysis: necrosis, regeneration, fibrocartilage, and normal bone [7].

CT scans allow for three-dimensional analysis of the growing hip, although considered supplementary. In our series, CT was used for early disease staging in three patients. Ultrasound, due to its safety and ease, is often used in early stages to detect increased joint space [8]. Arthrography offers excellent evaluation of femoral head morphology and subluxation, ideally performed under general anesthesia to relax muscles and improve accuracy.

Surgical techniques for acetabular augmentation involve harvesting an autologous bone graft from the iliac crest, which must cover both the lateral and anterior femoral head. The graft should be flush with the joint capsule but not too tight to avoid joint stiffness. Proper placement and volume are critical to avoid movement limitations [8]. Postoperatively, the child may be immobilized in a plaster cast or placed in traction, with gradual reintroduction of movement and weight-bearing [9]. Early complications can include infection and thromboembolism [10], while late complications may

involve joint stiffness or ossifications around the graft. Proper surgical technique and postoperative care are essential for optimal outcomes [11].

Some articles have reported an epiphysiodesis effect on the growth cartilage of the acetabulum after a shelf procedure, explained by the topographic proximity between the graft and the acetabular growth center. On the contrary, other articles have noted an acceleration in the growth rate of the acetabular cup. All these findings have been documented by 3D scanning. This notion of growth acceleration has also been reported by Yngve *et al*., [12], and by Joseph B [8]. Similar to Meyer J. [13], these authors noted this concept based on standard X-rays.

Therefore, the shelf procedure allows a certain degree of acetabular remodeling, leading to improved joint congruence in cases of Legg-Calvé-Perthes disease (LCP) treated from the fragmentation stage in children over 8 years old. This acetabular improvement has not been observed, for example, after femoral varus osteotomy. We agree with Yoo *et al*., [14], that cases of post-shelf epiphysiodesis are due to technical errors. Indeed, the orientation of the graft must respect the acetabular growth center. The preparation of the trench in children should take this detail into consideration, and the Salmon technique seems particularly suitable for children.

CONCLUSION

The hip shelf procedure is a reliable surgical intervention for LCPD, particularly in older children with severe disease and early head deformities. It enhances hip joint stability and function, contributing to favorable long-term outcomes. Early diagnosis and timely surgical intervention are paramount in achieving optimal results.

Declarations

Ethics Approval and Consent to Participate: The study was conducted according to ethical standards. Informed consent was obtained from the patient's guardian.

Consent for Publication: Written consent for publication of this case report and accompanying images was obtained from the patient's guardian. A copy is available upon request.

***Availability of Data and Material*:** Data supporting the findings are included in the article. Additional data are available from the corresponding author on request.

Competing Interests: The authors declare no competing interests.

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Authors' Contributions: All authors approved the final manuscript.

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