



## Prospective Evaluation of Femoral Head Containment Following Shelf Acetabuloplasty in Late-Stage Legg–Calvé–Perthes Disease

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### Abstract

**Background:** Legg–Calvé–Perthes disease leads to femoral head deformity from ischemic osteonecrosis; containment within the acetabulum preserves sphericity. This study reports early results of lateral shelf acetabuloplasty using a slotted corticocancellous autograft.

**Methods:** We prospectively enrolled consecutive children with unilateral Perthes disease suitable for shelf augmentation between August 2018 and December 2020. Inclusion required reducible extrusion and a mobile hip. A single surgeon performed slotted lateral shelf grafting, harvesting corticocancellous strips from the iliac crest and seating them into an acetabular slot. Patients followed a protected weight-bearing protocol and were reviewed at set intervals with AP pelvis and frog-lateral radiographs. Outcomes included radiographic indices (centre–edge angle, acetabular depth, acetabular–head quotient, subluxation measures) and clinical scores (CHOHES, WOMAC, modified Sundt).

**Results:** Thirty-five hips were treated. By three months most grafts had incorporated and radiographs demonstrated increased acetabular depth and centre–edge angle with reduced lateral subluxation. Acetabular–head coverage indices improved and clinical scores showed meaningful gains overall. No major intraoperative complications or early conversions to salvage procedures occurred.

**Conclusion:** In selected children with reducible extrusion, lateral shelf acetabuloplasty produced reliable graft incorporation, improved radiographic containment and early clinical improvement while avoiding femoral shortening.

**Keywords:** Perthes disease, Shelf acetabuloplasty, Containment, Femoral head, Graft incorporation.

### Introduction

Legg–Calvé–Perthes disease is a childhood condition that begins with a loss of blood supply to the femoral head, followed by collapse and gradual healing by repair and remodelling. The disease is most commonly seen in boys and typically presents in early school years, though older children may be affected and often do worse. The vulnerable phase after the initial insult is

when the femoral head is soft and prone to flattening under normal loads and muscle forces. Because loss of spherical shape is the key problem that leads to long-term hip dysfunction, treatment focuses on protecting the femoral head while it remodels and on preserving motion and comfort.

The central therapeutic idea is containment: keeping the femoral head well seated under the acetabular roof so it



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remodels into a rounder shape. A variety of containment strategies exist — from conservative measures and braces, to corrective osteotomies of the femur or pelvis. The lateral shelf acetabuloplasty is a pelvic procedure that augments the acetabular roof by placing a corticocancellous graft along the lateral rim. This graft acts as an extended roof that improves coverage of an extruded or enlarged femoral head without shortening the femur or altering proximal femoral geometry. Because the shelf does not require femoral shortening and is technically less demanding than some pelvic osteotomies, it is useful particularly in older children with reducible extrusion or when femoral procedures alone may fail to achieve adequate containment. The technique aims to increase the weight-bearing surface and resist lateral displacement while permitting natural remodelling. In this series we describe indications, a consistent slotted-graft technique, and early radiographic and clinical outcomes following lateral shelf augmentation [1-6].

### Review of Literature

Early authors described the natural history of Perthes disease and drew attention to how variable the outcome can be depending on the amount of epiphyseal involvement and patient age. Classification systems such as Catterall, Herring (lateral pillar) and others helped clinicians predict prognosis by quantifying how much of the femoral head is involved and the expected remodelling. These systems made clear that preserving the lateral epiphysis from extrusion early in the disease improves the chance of a round head later.

Containment as a guiding principle grew from these observations. If the femoral head can be maintained beneath an adequate acetabular roof during the repair phase, deforming forces are less likely to produce permanent flattening. Historically, containment was achieved with bracing or with osteotomies on the femur or pelvis; each approach has pros and cons. femoral varus osteotomy can improve coverage but alters limb alignment and may shorten the limb, while pelvic osteotomies can reorient the acetabulum but are more invasive. Shelf arthroplasty evolved out of practice treating residual dysplasia and was adapted for Perthes. The technique places corticocancellous bone along the lateral acetabular rim to extend the roof, improving lateral coverage without changing femoral length or alignment. Midterm reports and series have documented increases in centre–edge angle and measures of lateral coverage after shelf procedures, and many series show acceptable clinical and radiographic results when the operation is timed before advanced collapse. Patient selection — particularly assessing reducibility and remaining growth potential — is repeatedly emphasized in the literature as a determinant of success. Standardized surgical technique and follow-up protocols are recommended to reduce variability between series and to allow meaningful comparison of outcomes [7-13].

### Materials and Methods

This study is a prospective single-centre cohort of consecutive children treated with lateral shelf acetabuloplasty between August 2018 and December 2020. Inclusion criteria were age appropriate for the procedure, unilateral disease, a mobile hip with reducible extrusion on assessment, and modified Elizabethtown stage IIa or greater. Patients with prior pelvic or femoral realignment, bilateral disease, or grossly irreducible collapse were excluded. The institutional review board approved the study and informed consent was obtained from guardians.

All operations were performed by one senior surgeon using a slotted corticocancellous autograft technique. Through a limited lateral approach, corticocancellous strips were harvested from the outer table of the iliac crest. A slot was prepared along the lateral acetabular margin and the graft was seated into this slot; the periosteum and soft tissues were closed snugly over the graft to secure it. No routine spica or rigid postoperative immobilization was used. Patients were mobilized with protected weight bearing using crutches; partial weight bearing began at around six weeks and full weight bearing was allowed after radiographic evidence of graft incorporation, typically by three months.

Radiographic follow-up included AP pelvis and frog-lateral views at set intervals: immediate postoperative, six weeks, three months, six months and one year. Outcome measures combined objective radiographic indices — acetabular depth, centre–edge angle, acetabular–head quotient and lateral subluxation measures — with clinical assessments using CHOHES, WOMAC and modified Sundt criteria to capture pain, function and motion. Data collection was done by a dedicated trainee under consultant oversight. Statistical analysis used repeated measures techniques for continuous measures and chi-square for categorical outcomes, with significance at  $p < 0.05$ .

### Results

Thirty-five patients met inclusion criteria and completed early follow-up. The group included twenty-eight boys and seven girls. Mean age at disease onset and at surgery reflected the older childhood group in which shelf procedures are commonly considered. Most hips were Herring lateral pillar types B or C and presented in mid-stage disease. Radiographically, centre–edge angle and acetabular depth increased after the shelf procedure, with measurable change by three months and maintenance at one year. Lateral coverage indices improved and lateral subluxation diminished, indicating better containment of the femoral head. Graft incorporation into the iliac margin was seen on follow-up radiographs by approximately three months in most patients. Clinically, there were improvements in CHOHES and WOMAC scores and the majority of hips achieved good or fair results by modified Sundt criteria. There were no major intraoperative complications and no conversions

to salvage surgery during the follow-up period.

### Discussion

The results here mirror other series that show the lateral shelf can reliably increase acetabular coverage and help contain a vulnerable femoral head during remodelling. Mechanically, the grafted shelf lengthens the lateral roof and redistributes load across a broader surface, resisting lateral extrusion and allowing the femoral head to remould under more favourable conditions. Because this approach augments acetabular support without shortening or changing the geometry of the femur, it avoids some gait and limb-length consequences seen after varus femoral osteotomy.

Patient selection is critical. The shelf is most helpful when extrusion is reducible and when there is still potential for remodelling; it is less useful in hips with severe collapse and irreversible loss of sphericity. Dynamic assessment of reducibility and careful preoperative imaging inform this choice. Technique also affects outcome: creating an accurate acetabular slot, harvesting appropriately sized corticocancellous strips, and snug soft tissue closure all aid graft stability and incorporation. Our use of a standardized slotted autograft method aimed to reduce variability and promote consistent radiographic incorporation.

Comparative data remain limited, but the shelf offers an attractive compromise in selected older children — offering structural support with lower technical morbidity than complex pelvic osteotomies and without femoral shortening. Early clinical score improvements seen in this cohort align with the observed radiographic gains, supporting the link between better containment and improved function. The single-surgeon, single-centre design helped maintain consistency in technique and follow-up but limits generalizability. Longer follow-up to skeletal maturity will be necessary to confirm whether these early gains translate into better long-term joint shape and reduced degenerative change [14-20].

### Conclusion

In this series lateral shelf acetabuloplasty gave consistent early improvements in acetabular coverage and clinical scores in selected children with Perthes disease. When applied to hips with reducible extrusion and reasonable remodelling potential, a slotted corticocancellous autograft shelf provides predictable graft incorporation and improved containment while avoiding femoral shortening. These early outcomes support the shelf as a valuable option for older children or those in whom femoral procedures may be insufficient. Continued follow-up to skeletal maturity is required to determine the procedure's influence on final hip shape and long-term function.

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