



Dual Small-Diameter Screw Fixation in Acute Traumatic Slipped Capital Femoral Epiphysis: A Case Report

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ABSTRACT

Slipped capital femoral epiphysis (SCFE) is typically a chronic condition associated with metabolic and biomechanical factors, whereas acute traumatic SCFE in a previously asymptomatic adolescent is uncommon and carries a higher risk of avascular necrosis (AVN). We report the case of a 15-year-old male who presented with acute right hip pain and inability to bear weight following high-energy trauma. Radiographs demonstrated an unstable SCFE with severe displacement and no radiographic features of chronicity. The patient underwent urgent closed reduction and percutaneous fixation using two 4.0 mm cannulated screws, consisting of one partially threaded and one fully threaded screw. Postoperatively, he was managed with staged non-weight-bearing followed by gradual return to full weight-bearing. At 12 months, the patient was asymptomatic with no radiological evidence of AVN or loss of reduction. Functional outcome assessment demonstrated excellent recovery, with a Non-Arthritic Hip Score of 97.5% and high Hip disability and Osteoarthritis Outcome Score values across domains, including pain (98.6), symptoms (98.5), activities of daily living (100), sports and recreation (93.75), and quality of life (100). This case shows a favorable short-term outcome following dual small-diameter screw fixation; however, given the single-case design and limited follow-up, no conclusions regarding implant superiority or reduction in AVN risk can be drawn. Further studies are required to evaluate this technique in unstable SCFE.

Keywords. acute traumatic slipped capital femoral epiphysis, dual screw fixation, hip preservation surgery, unstable slipped capital femoral epiphysis, cannulated screw fixation, adolescent hip trauma

INTRODUCTION

Slipped capital femoral epiphysis (SCFE) is one of the most common adolescent hip disorders and typically presents as a chronic or subacute physeal slip associated with mechanical and metabolic factors. Aprato et al. and Mahran et al. described SCFE as a multifactorial disorder commonly affecting adolescents during periods of rapid growth.^{1,2} Acute traumatic SCFE occurring in a previously asymptomatic adolescent is uncommon and may resemble a Salter-Harris type I physeal injury. Sankar et al. and Zaltz et al. reported that unstable slips are associated with a substantially higher risk of avascular necrosis (AVN), likely related to acute disruption of the femoral head blood supply.^{3,4}

Management of unstable SCFE remains challenging. While in situ fixation with a single cannulated screw is widely accepted for stable slips, the optimal fixation strategy for acute unstable injuries remains less clearly defined.^{5,6} Zaltz et al. reviewed multiple treatment approaches for unstable SCFE, including gentle closed reduction with percutaneous fixation and open reduction techniques, but concluded that evidence supporting one method over another remains limited.⁴ Napora et al. reported acceptable outcomes following purposeful closed

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reduction and pinning in unstable SCFE, whereas Kitano et al. identified closed reduction as a potential risk factor for AVN.^{7,8} Novais et al. demonstrated favorable short-term outcomes with the modified Dunn procedure in selected unstable slips, though there are still concerns regarding surgical complexity and complications.⁹

Multiple screw fixation has occasionally been described in unstable slips to improve rotational control; however, this approach risks additional physeal injury and lacks long-term evidence. We present a case of acute traumatic unstable SCFE managed with urgent closed reduction and fixation using two small-diameter cannulated screws. The objective of this report is to describe the surgical decision-making, technical considerations, and short-term clinical and radiological outcome of this approach in an uncommon injury pattern.

CASE

A 15-year-old male presented to the emergency department with severe right hip pain and inability to bear weight following a high-energy road traffic accident involving a lateral impact injury. The patient had no prior history of hip or knee pain, limp, restriction of activities, or known endocrine disorders. There were no clinical features suggestive of early puberty or underlying metabolic abnormality. His body mass index was 21 kg/m².

On examination, the right lower limb was held in external rotation with painful restriction of hip movements, particularly internal rotation, abduction, and flexion. The patient was unable to ambulate, and the slip was therefore classified as unstable according to the Loder classification system. No distal neurovascular deficit was identified.

Plain radiographs of the pelvis and right hip demonstrated marked posterior and inferior displacement of the femoral epiphysis consistent with slipped capital femoral epiphysis (SCFE) (Figure 1).

Based on Wilson's classification, the slip was categorised as severe, with displacement exceeding 50% of the width of the epiphysis. The Southwick slip angle measured more than 60 degrees. Ultrasonography of the hip demonstrated joint effusion without evidence of metaphyseal remodelling. Radiographs did not show features commonly associated with chronic SCFE, such as rounding of the superior femoral neck, reduction in epiphyseal height, metaphyseal remodelling, or callus formation at the metaphyseal junction.

The absence of prodromal symptoms, combined with the high-energy mechanism of injury and lack of radiographic signs of chronicity, supported the diagnosis of acute traumatic unstable SCFE. However, the possibility of an acute-on-chronic slip could not be excluded in the absence of advanced imaging.

Surgical intervention was performed within 12 hours of presentation. The patient was positioned supine on a radiolucent operating table. Under fluoroscopic guidance, gradual longitudinal traction was applied, followed by gentle controlled internal rotation to correct the externally rotated deformity. To minimize additional injury to the femoral head vascular supply, no forceful manipulation or repeat attempts were performed. Reduction was achieved in a single attempt and confirmed on anteroposterior and lateral fluoroscopic views. Fixation was performed using two 4.0 mm cannulated screws inserted percutaneously. A partially threaded screw was placed centrally across the physis to provide compression and initial stability. This was supplemented with a fully threaded screw inserted in a divergent orientation to improve rotational control while minimizing additional compression across the physis. Care was taken to avoid joint penetration, and both screws achieved secure epiphyseal purchase with four threads crossing the epiphysis.

Postoperatively, the patient remained non-weight-bearing for six weeks, followed by gradual progression to partial and full weight-bearing. Clinical and radiographic follow-up was performed at two weeks, six weeks, three months, six months,

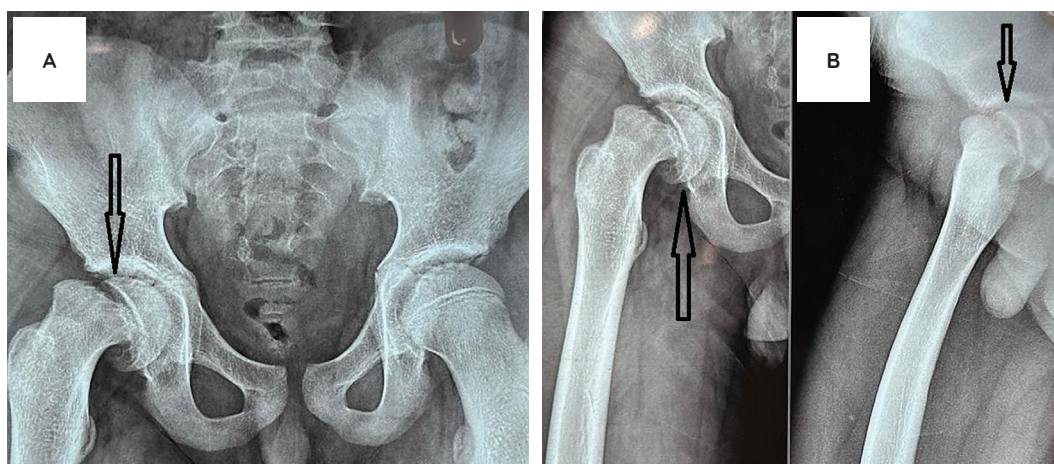


Figure 1. Preoperative anteroposterior and lateral radiographs demonstrating unstable slipped capital femoral epiphysis. Anteroposterior radiograph showing marked displacement of the proximal femoral epiphysis (A). Lateral radiograph demonstrating posterior displacement of the epiphysis (B).

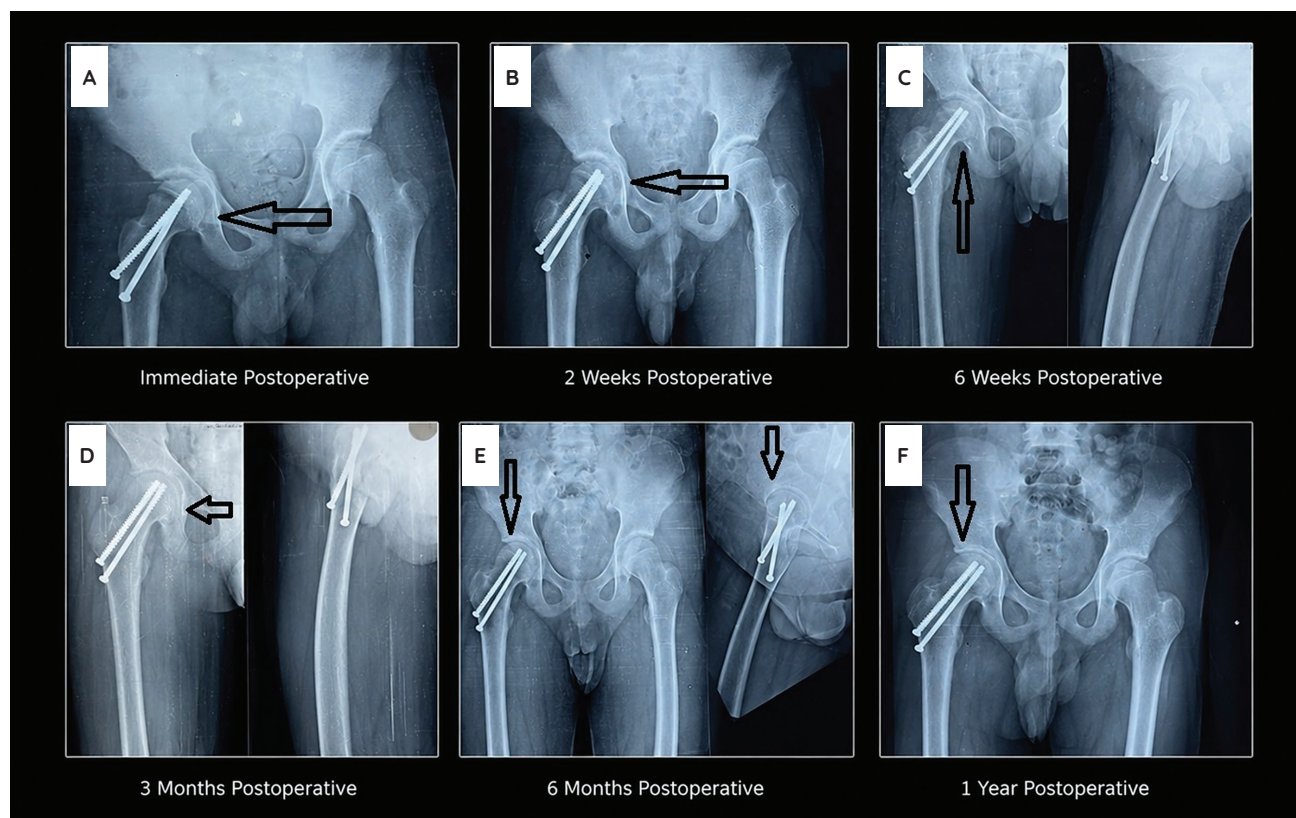


Figure 2. Serial radiographic evaluation of a 15-year-old male with acute traumatic slipped capital femoral epiphysis managed with dual 4.0 mm screw fixation. Immediate postoperative radiographs showing satisfactory closed reduction and placement of dual cannulated screws within the femoral epiphysis without joint penetration (A). Two-week follow-up demonstrating maintained reduction and stable implant position (B). Six-week follow-up showing progressive healing without loss of fixation (C). Three-month follow-up with continued stability and early signs of physeal closure (D). Six-month follow-up radiographs demonstrating maintained alignment and absence of femoral head collapse (E). One-year follow-up showing complete physeal fusion with no radiographic evidence of avascular necrosis or joint space compromise (F).

and one year after surgery. Serial radiographs demonstrated maintained reduction, progressive physeal closure, and no evidence of implant failure, femoral head collapse, or avascular necrosis (Figure 2).

At each follow-up visit, pain, gait pattern, hip range of motion, and functional limitation were assessed. The patient showed progressive improvement without recurrence of hip pain, stiffness, limp, or restriction of daily activities. There was no clinical evidence suggestive of chondrolysis, such as painful progressive loss of hip motion. Follow-up radiographs demonstrated preservation of joint space without narrowing or degenerative changes. At final follow-up, the patient had returned to routine daily activities and non-competitive sports without pain or gait disturbance. Functional assessment demonstrated excellent recovery, with a modified Harris Hip Score (mHHS) of 96 as described by Harris et al. The patient also demonstrated favorable patient-reported outcomes, with a Non-Arthritic Hip Score of 97.5% and high HOOS values across all domains, including pain (98.6), symptoms (98.5), activities of daily living (100), sports and recreation (93.75), and quality of life (100). Clinical examination at final follow-up demonstrated satisfactory active range of motion of the hip with the ability to perform squatting and cross-legged sitting without discomfort (Figure 3).

DISCUSSION

Acute traumatic unstable SCFE represents an uncommon injury pattern that differs from the more frequently encountered acute-on-chronic SCFE. Typical SCFE develops due to gradual physeal weakening related to mechanical, endocrine, and metabolic factors, often with preceding symptoms such as hip pain, thigh pain, knee pain, or limp. In contrast, traumatic SCFE occurs after a significant injury mechanism in a previously asymptomatic adolescent and closely resembles a Salter-Harris type I physeal separation through the proximal femoral physis. Therefore, treatment priorities include restoration of alignment with minimal additional vascular compromise and stable fixation until physeal healing. Management of unstable SCFE remains controversial because no single technique has consistently demonstrated superior outcomes across all patient groups.^{4,6} Closed reduction with percutaneous fixation continues to be used by many surgeons because it avoids the morbidity associated with open procedures, although concern persists regarding further compromise of femoral head vascularity during manipulation.^{7,8} In the present case, acceptable alignment was achieved with gentle reduction in a single attempt, avoiding the need for surgical dislocation or open reduction.



Figure 3. Clinical outcome at 12-month follow-up demonstrating functional recovery of the right hip following urgent closed reduction and percutaneous fixation with two 4.0 mm cannulated screws for acute traumatic unstable slipped capital femoral epiphysis. Demonstration of active straight leg raise with good hip flexor strength (**A**), active hip flexion to approximately 90° in the supine position (**B**), active straight leg raise with the knee extended, demonstrating maintained hip flexion and quadriceps function (**C**), active hip abduction in the supine position, showing satisfactory abductor function (**D**), neutral lower limb alignment with full knee extension in the supine position (**E**), passive hip internal rotation demonstrating satisfactory postoperative range of motion (**F**), passive hip external rotation demonstrating satisfactory postoperative range of motion (**G**), ability to perform a full squat without pain or functional limitation (**H**), and ability to sit cross-legged comfortably, indicating good hip flexion, abduction, and external rotation (**I**).

The modified Dunn procedure has been advocated for severe unstable slips because it permits direct correction of deformity while preserving femoral head perfusion.⁹ Despite favorable short-term results reported in selected series, the procedure remains technically demanding and carries a recognized risk of complications related to surgical dislocation and vascular injury.^{2,4} Consequently, less invasive fixation strategies may still be considered when satisfactory reduction can be achieved without forceful manipulation. The decision to use two small-diameter screws in this patient was based on perceived rotational instability after reduction. Biomechanical studies by Pritchett and Perdue and by Leblanc et al. suggested that multiple points of fixation may improve rotational control compared with a single-screw construct.^{10,11} However, available evidence remains limited to theoretical models and small clinical reports. Accordingly, this case does not establish superiority of dual-screw fixation or reduction in AVN risk. The technical modification in this case was not the use of multiple fixation points alone, but the use of two smaller-diameter screws to achieve rotational stability while limiting overall implant volume within the femoral epiphysis. This approach was selected based on intraoperative assessment of stability after reduction rather than as a routine alternative to conventional single-screw fixation.

An additional theoretical consideration relates to implant volume within the femoral epiphysis. The combined cross-sectional area of two 4.0 mm screws is smaller than that of a single 7.3 mm screw, resulting in reduced overall implant occupancy within the epiphysis. Whether this difference has any effect on intra-osseous pressure or femoral head perfusion in unstable SCFE remains uncertain, as no vascular or biomechanical assessment was performed in the present case.

Accordingly, this observation should be interpreted as a conceptual consideration rather than evidence of clinical advantage over standard single-screw fixation. Multiple screw fixation also introduces potential disadvantages that must be acknowledged. Additional implants crossing the physis may increase the risk of physeal injury, chondrolysis, hardware conflict, or difficulty during future implant removal procedures. These considerations are particularly relevant in skeletally immature patients, where physeal integrity must be preserved.^{1,2}

At one-year follow-up, reduction was maintained, the physis was closed, and there were no radiographic signs of AVN. Functional recovery was favorable, with high NAHS and HOOS values across pain, activity, and quality-of-life domains.^{12,13} These patient-reported outcome measures provided a broader assessment of postoperative recovery than the modified Harris Hip Score alone and may be more suitable for adolescent patients undergoing hip preservation procedures.¹⁴

The timing of surgery is still debated in the literature. Kohnno et al. observed a possible association between delayed surgical intervention and the development of AVN after unstable SCFE.¹⁵ Veramuthu et al. reported substantial variation in

AVN prevalence across different treatment strategies in their systematic review and meta-analysis.¹⁶ Considerable variation in management preferences among pediatric orthopaedic surgeons further reflects the absence of universally accepted treatment guidelines.¹⁷ In the present case, fixation was performed within 12 hours of injury, which may have contributed to the favorable early outcome. However, this outcome should be interpreted cautiously because complications such as avascular necrosis, femoroacetabular impingement, chondrolysis, and early degenerative changes may develop after longer follow-up periods.

This report has several limitations. It represents a single case with short-term follow-up and no comparison to alternative fixation methods. Dedicated preoperative cross-table lateral radiographs of both hips were not available, limiting detailed bilateral radiographic comparison. Intraoperative images demonstrating the reduction maneuver, guidewire placement, and sequential screw insertion were also unavailable, which limits visual documentation of the surgical technique. Advanced imaging was not performed to assess femoral head perfusion or definitively exclude an acute-on-chronic slip. No biomechanical or vascular evaluation was undertaken, and the observations described here should therefore be interpreted cautiously. Longer follow-up is also necessary to evaluate late complications such as femoroacetabular impingement, deformity progression, and osteoarthritis. Continued surveillance remains important because patients with unilateral SCFE are at risk for subsequent contralateral involvement, particularly in the presence of skeletal or growth-related risk factors.¹⁸⁻²⁰

CONCLUSION

Acute traumatic unstable SCFE is an uncommon injury pattern associated with substantial risk of complications, particularly avascular necrosis. In this patient, urgent closed reduction followed by fixation with two small-diameter cannulated screws resulted in maintained reduction, physeal closure, absence of radiographic AVN, and favorable functional recovery at one-year follow-up.

Although dual small-diameter screw fixation provided satisfactory short-term stability in this case, the findings should be interpreted cautiously given the absence of comparative, vascular, and biomechanical evaluations. This report should therefore be regarded as a description of surgical technique and short-term clinical outcome rather than evidence supporting routine use of dual-screw fixation in unstable SCFE.

Further studies with larger patient cohorts and longer follow-up are required to clarify the role of this approach.

ETHICAL CONSIDERATION

Patient's consent was obtained before submission of the manuscript.

STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

CREDIT AUTHOR STATEMENT

JB: Conceptualization, Methodology, Validation, Formal Analysis, Data Curation, Writing – original draft preparation, Writing – review and editing; **ZI:** Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Writing – review and editing, Supervision; **AD, CRB, MG:** Conceptualization, Methodology, Validation, Data Curation, Writing – review and editing, Supervision.

DATA AVAILABILITY STATEMENT

No datasets were generated or analyzed for this study.

AUTHOR DISCLOSURE

The authors declared no conflict of interest.

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