



RELIABLE FIXATION AND FAVORABLE UNION FOLLOWING OPEN REDUCTION AND INTERNAL FIXATION USING HEADLESS CANNULATED COMPRESSION SCREWS IN PEDIATRIC FEMORAL NECK FRACTURE: A CASE REPORT

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ABSTRACT

Pediatric femoral neck fractures are rare, accounting for less than 1% of pediatric fractures, but carry substantial risks of avascular necrosis (AVN), nonunion, and growth disturbance. Early diagnosis and stable fixation are essential, although the optimal fixation method in adolescents remains controversial. To describe the clinical and radiographic outcomes of open reduction and internal fixation using headless cannulated compression screws in an adolescent with a nondisplaced femoral neck fracture. A 13-year-old boy presented with acute right hip pain and inability to bear weight after falling from a bunk bed. Radiographs demonstrated a nondisplaced Garden type II femoral neck fracture. Open reduction and internal fixation were performed using three headless cannulated compression screws in a triangular configuration under fluoroscopic guidance. Anatomic reduction and stable fixation were achieved. A staged rehabilitation protocol was initiated postoperatively. Serial radiographs showed progressive fracture healing, with assisted ambulation at 3 months and full, pain-free hip function at 6 months. Accurate reduction and stable fixation are critical to prevent secondary displacement and minimize AVN risk. Headless cannulated compression screws provide interfragmentary compression, rotational stability, and minimal physal disruption. In this case, timely surgery and stable fixation resulted in fracture union without complications. Open reduction and internal fixation using headless cannulated compression screws achieved reliable union, preserved hip function, and avoided major complications, supporting its use as a treatment option for nondisplaced femoral neck fractures in adolescents.

Keywords: adolescent hip fracture; avascular necrosis; headless cannulated compression screw; open reduction and internal fixation; pediatric femoral neck fracture

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INTRODUCTION

Pediatric femoral neck fractures account for less than 1% of all childhood fractures but pose significant challenges due to the tenuous blood supply to the femoral head (Spence et al., 2015). This vascular vulnerability predisposes patients to complications such as avascular necrosis (AVN; reported rates 0–92%), nonunion, coxa vara, and premature physal closure leading to growth disturbances (Moon & Mehlman, 2006). Garden type II fractures, characterized by incomplete displacement with no cortical override, are particularly demanding as they often require precise anatomic reduction to preserve vascularity while minimizing physal injury (Medda et al., 2019). An updated systematic review and meta-analysis of pediatric femoral neck fractures including studies up through 2025 found that older age (≥ 12 years), Garden type I/II fractures, initial displacement, and poor reduction quality were all significantly associated with higher AVN risk. Early reduction and closed reduction/internal fixation were associated with better long-term outcomes (Moon & Mehlman, 2006). Specifically for incomplete/displaced fractures (such as Garden type II), available evidence confirms that even minimal displacement significantly increases

disruption of femoral head perfusion, hence careful anatomic reduction with preservation of physeal integrity is crucial to minimize further vascular compromise and long-term growth disturbances (Li et al., 2022).

In adolescents approaching skeletal maturity, management must balance rigid mechanical stability with preservation of the proximal femoral physis and femoral head vascularity. Various fixation strategies, including cannulated screws and dynamic hip screws, have been described, yet concerns remain regarding physeal injury and vascular compromise. Headless cannulated compression screws (HCCS) have emerged as an alternative designed to provide continuous interfragmentary compression while minimizing hardware prominence and physeal disruption. Despite promising reports, the consensus regarding the optimal fixation technique in adolescent femoral neck fractures remains an ongoing debate. This case report describes successful open reduction and internal fixation using HCCS in a 13-year-old patient and highlights technical considerations and clinical outcomes. This case report evaluate the clinical and radiographic outcomes of open reduction and internal fixation using headless cannulated compression screws in an adolescent with a nondisplaced femoral neck fracture.

METHOD

Case Presentation

This case report describes the clinical management and postoperative outcomes of a 13-year-old boy with a nondisplaced femoral neck fracture treated with open reduction and internal fixation using headless cannulated compression screws. Clinical information, imaging findings, operative details, postoperative rehabilitation, and follow-up outcomes were obtained from the patient's medical records and serial clinical and radiographic assessments. The case was reported in accordance with the principles of the CARE guidelines for case reports.

Clinical and Radiographic Assessment

Initial evaluation included a detailed history of the mechanism of injury, physical examination, assessment of limb alignment and hip mobility, and neurovascular examination. Standard anteroposterior and lateral pelvic radiographs were obtained to characterize the fracture pattern and assess displacement. The fracture was classified according to the Garden classification. Follow-up assessment included serial radiographs to evaluate fracture alignment, progression of union, and implant position. Clinical recovery was assessed based on pain, hip range of motion, weight-bearing ability, return to activity, and the Harris Hip Score at final follow-up. The occurrence of complications, including avascular necrosis, nonunion, implant failure, and limb-length discrepancy, was also evaluated.

Surgical Technique

Open reduction and internal fixation were performed within 24 hours of injury. The procedure was conducted through a lateral minimally invasive approach using a Hardinge approach. Fracture reduction was performed under fluoroscopic guidance with the objective of restoring anatomical alignment while preserving the proximal femoral physis and avoiding additional soft-tissue and vascular injury. Fixation was achieved using three 7.3-mm fully threaded headless cannulated compression screws inserted in a triangular configuration. Screw placement, fracture reduction, and implant position were assessed intraoperatively using anteroposterior and lateral fluoroscopic views. Particular attention was given to maintaining an appropriate screw trajectory and avoiding penetration of the physis or femoral head articular surface.



Figure 1. Intra Operative C-Arm Imaging of Minimal Invasive Approach.

Postoperative Management and Follow-up

Postoperatively, the patient was maintained non-weight bearing for 4 weeks, followed by progressive partial weight bearing with assistive devices until 16 weeks. Full weight bearing was subsequently permitted as tolerated based on clinical and radiographic evidence of fracture healing. Clinical and radiographic follow-up was performed serially, with assessment of fracture union, maintenance of alignment, implant integrity, hip function, and potential complications. The final clinical outcome was assessed at 1 year postoperatively.



Figure 2. Serial Pelvic X-Ray.



Figure 3. Three Months Evaluation After Operation.



Figure 4. Six Months Evaluation After Operation

Ethical Considerations

Written informed consent for publication of the patient's clinical information and radiographic images was obtained from the patient's parent or legal guardian. Patient-identifying information was excluded from the manuscript to maintain confidentiality.

RESULT

DISCUSSION

Pediatric femoral neck fractures are uncommon but carry a disproportionately high risk of complications due to the precarious vascular supply of the femoral head, primarily derived from the posterior branch of the medial circumflex femoral artery (Spence et al., 2015; Pettett et al., 2021). Even minimally displaced fractures may compromise femoral head perfusion and increase the risk of avascular necrosis (AVN), particularly in adolescents. Recent systematic reviews and meta-analyses have identified older age (≥ 12 years), fracture displacement, delayed intervention, and poor reduction quality as significant predictors of AVN (Dong et al., 2025). Early surgical management within 24 hours has been associated with improved outcomes and reduced complication rates (Regmi et al., 2024).

The primary objectives of treatment are anatomical reduction, stable fixation, and preservation of femoral head vascularity (Moon & Mehlman, 2006; Pavone et al., 2019). In adolescents approaching skeletal maturity, sufficient mechanical stability must be achieved while minimizing physeal disruption. Traditional fixation methods such as partially threaded cannulated screws have demonstrated satisfactory union rates but are associated with variable AVN incidence (Medda et al., 2019; Wang et al., 2022). Headless cannulated compression screws (HCCS) have been proposed as an alternative implant that provides continuous interfragmentary compression, enhanced rotational stability, and minimal hardware prominence, thereby reducing soft-tissue irritation and potential physeal violation (Wang et al., 2022; Mandala et al).

Recent pediatric evidence supports the use of HCCS in selected cases. Jiang et al. (2025) reported complete radiographic union in all 12 children treated with HCCS for Delbet-Colonna II and III fractures, with no surgery-related complications at a mean follow-up of approximately 24 months (Jiang et al., 2025). Similarly, broader analyses of screw fixation in pediatric femoral neck fractures have demonstrated high union rates when anatomical reduction and stable fixation are achieved (Moon & Mehlman, 2006; Talmaç et al., 2025). Comparative data in adult and geriatric populations also suggest lower fixation failure rates with headless constructs compared with conventional screw systems, supporting their biomechanical advantages (Chen et al., 2025).

In the present case, early intervention within 24 hours, precise fluoroscopic guidance, and triangular screw configuration allowed stable fixation without violation of the proximal femoral physis. Careful attention to screw trajectory helped avoid disruption of the femoral head blood supply, as

emphasized in anatomical studies (Pettett et al., 2021). The patient achieved complete union and excellent functional recovery, consistent with favorable outcomes reported in nondisplaced fractures managed with early internal fixation (Moon & Mehlman, 2006; Dong et al., 2025).

Limitation

This report is limited by its single-case design and relatively short-term radiographic follow-up. Magnetic resonance imaging was not performed to evaluate baseline femoral head perfusion. Larger prospective comparative studies are required to determine whether headless cannulated compression screws offer superior long-term outcomes compared with conventional fixation techniques in pediatric populations.

CONCLUSION

Open reduction and internal fixation using headless cannulated compression screws under fluoroscopic guidance provides stable fixation, preserves femoral head vascularity, and promotes reliable fracture union in adolescent femoral neck fractures. In this case, the technique resulted in excellent functional recovery without complications. Headless cannulated compression screw fixation represents a safe and effective treatment option for nondisplaced femoral neck fractures in adolescents when performed with careful surgical planning and early intervention.

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