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CASE REPORT / CASE SERIES

# Management of Long, Comminuted Pediatric Subtrochanteric Fractures Using PHILOS (Proximal Humeral Internal Locked System): A Case Series

Pocholo Iñigo B. Morales, MD, Victor Illescas, MD, Julyn Aguilar, MD, Reggie Torredes, MD, Richard Rotor, MD, Jason Santiago, MD

*Section of Children's Orthopedics, Philippine Orthopedic Center, Quezon City*

## ABSTRACT

Subtrochanteric fractures in the pediatric population are rare, and there are currently no existing management guidelines. In this innately unstable fracture type, intramedullary devices preferred for adults cannot be used in children with open growth plates. A PHILOS locking plate is meant to be used in the management of proximal humerus fractures in adults, and its secondary use in children has been sparsely described in the literature.

Four pediatric patients (age range 8–14 years) with comminuted subtrochanteric femur fractures with a length averaging 7 cm (range 3.5–9.5 cm) were managed via open reduction and internal fixation using PHILOS (Proximal Humeral Internal Locked System) plates by the same surgeon and were followed up for six months, all resulting in excellent outcomes.

The PHILOS plate is a viable option in the management of subtrochanteric femur fractures in the pediatric population and long complex fracture patterns without violating the greater trochanteric physis.

**Keywords.** ESIN, PHILOS, pediatric subtrochanteric femur fracture

## INTRODUCTION

Subtrochanteric fractures in the pediatric population are rare, with an incidence of 4–10% among pediatric femoral fractures.[1] Although there have been no guidelines in management if alignment cannot be attained by conservative means (usually with 90-90 skeletal traction), and in patients older than 10 years, surgical management is recommended using different methods such as reconstruction plates, dynamic compression plates, and adult pre-contoured locking plates.[2]

Gogna et al. in 2014 were the first to publish a series on the novel use of the adult proximal humerus locked plate in the management of subtrochanteric fractures in eight pediatric patients aged 10–16 years with the fracture patterns as follows: four long spiral, two short obliques, one transverse, and one comminuted.[3]

Chew et al. also described the use of a PHILOS plate in managing a subtrochanteric femur fracture in a 13-year-old patient with excellent results, followed over six months.[4]

## CASE 1

An 8-year-old boy presented with right thigh pain and deformity after being trampled on by another child during a basketball match. Radiographs show a comminuted subtrochanteric

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Corresponding author: Pocholo Iñigo B. Morales, MD
Section of Children's Orthopedics,
Philippine Orthopedic Center
Maria Clara Street, Quezon City, 1114
Tel. No.: +63(2) 8711 4276
E-mail: pochmorales@gmail.com

femur fracture with a minimally displaced proximal segment (Figure 1).

He underwent open reduction, and fixation with a 12-hole PHILOS plate under general anesthesia at 12 days post-injury. Intra-operatively, the surgeon noted that the spiral comminution was 9.5 cm long. Three Kirschner wires were initially used to maintain reduction before applying two lag screws outside the PHILOS plate. The two most proximal locking screw holes were left empty since they were directed away from the narrow femoral neck. Intra-operative blood loss was 700 cc, requiring a transfusion of one unit of packed red blood cells (PRBC). A posterior half-cylinder spica mold was placed, and the patient was allowed toe-touch weight bearing with crutches and range of motion exercises (ROM) of the ankle.

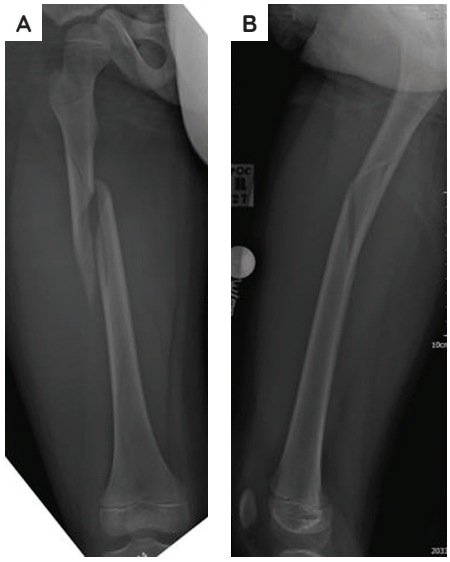


**Figure 1.** ***Case 1***. Radiographs show a wedge spiral comminuted proximal femur, frontal **(A)** and lateral **(B)** view.

At three months post-op, the patient could ambulate with full weight-bearing without crutches. The range of motion of the hip and knees was full and equal. On radiographs, we observed a union at the fracture site.

At six months post-op, the patient was able to ambulate with full weight-bearing without crutches, with a full range of motion (Figure 2).

## CASE 2

A 9-year-old girl presented with bilateral thigh deformities a few hours after being hit by a jeepney, and was subsequently diagnosed with a closed, transverse midshaft femur fracture on the right, and a closed, minimally displaced, comminuted subtrochanteric fracture on the left (Figure 3).

Initially with hemoglobin of 132 mg/dL on the day of injury, decreasing to 86 mg/dL on day two post-injury, she was hemodynamically stabilized through transfusion of two units PRBC before undergoing closed reduction and fixation using two 2.5 mm elastic stable intramedullary nailing (ESIN) rods on the right, and open reduction, fixation with a 12-hole PHILOS plate on the left under general anesthesia at seven days post-injury.

Intra-operatively, we noted that the comminution on the left subtrochanteric femur was 8 cm long. Two lag screw screws were applied within the 12-hole 26 cm PHILOS plate, which afforded compression of the fragments, converting the complex fracture into a two-part fracture. The two most proximal locking screw holes were left empty to avoid damaging the physis of the greater trochanter.

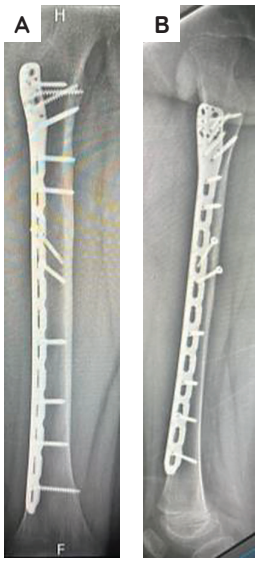


**Figure 2.** ***Case 1***. Radiographs at six months post-op show union on both fracture sites and equal femur lengths, frontal view **(A)** and lateral view **(B)**.

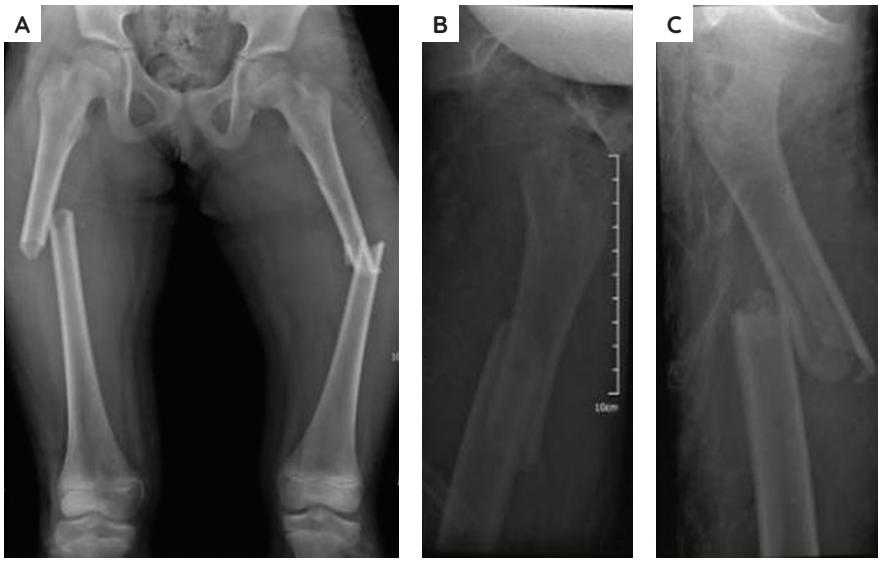


**Figure 3.** ***Case 2***. Injury radiographs show a simple midshaft femur fracture on the right and a minimally displaced, comminuted subtrochanteric fracture on the left, bilateral frontal view **(A)**, lateral view of right **(B)**, lateral view of left **(C)**.

Closed ESIN fixation took 1.5 hours, while open PHILOS plating took 2.5 hours, for a total of 4 hours of surgical time. The total intra-op blood loss was 500 cc, and 1 unit of PRBC was transfused intra-op. Hemoglobin at day one post-op was 110 mg/dL. True leg lengths were equal. Post-op angulations were a one-degree varus on the right and an anatomic reduction on the left.

A posterior half-cylinder spica mold was placed on the right lower extremity, and the patient was allowed no weight bearing for a total of 12 weeks, allowing only range of motion exercises of both hips and knees starting two weeks post-op.

At three months post-op, both limbs were equal in length, and the patient was able to stand on both lower extremities with full weight bearing.

At six months post-op, the patient was able to ambulate on full weight bearing without crutches, with full range of motion.

## CASE 3

A 14-year-old male presented with left thigh pain and deformity after falling from a 10-foot-tall coconut tree. Radiographs show a comminuted, primarily reverse oblique subtrochanteric femur fracture with a pertrochanteric extension (Figure 5).

He underwent open reduction, and fixation with a 10-hole PHILOS plate under spinal anesthesia at 15 days post-injury. Intra-operatively, we noted that the fracture was 7.5 cm long. The reduction was maintained with a Lohmann, a Verbrugge, and a Kirschner wire before applying two lag screws outside the PHILOS plate. A total of four locking screws were placed proximal to and five distal to the fracture site. Intra-operative blood loss was 800 cc, requiring a transfusion of two units of PRBC, and the surgery was done in 3.5 hours. A posterior half-cylinder spica mold was also placed, and the patient was allowed toe-touch weight bearing with crutches.

At six months post-op, the patient was able to ambulate on full weight-bearing without crutches. The range of motion of the hips and knees was full and equal.

## CASE 4

A 13-year-old male presented with right thigh pain and deformity after being hit by a van while riding a motorcycle. Radiographs show a comminuted, subtrochanteric femur fracture.

He underwent open reduction, and fixation with a 10-hole PHILOS plate under spinal-epidural anesthesia at 26 days post-injury. Intra-operatively, we noted that the fracture was 3.5 cm long with a small, comminuted fragment. The reduction was maintained with two Verbrugges. A total of five locking screws were placed proximal to and distal to the fracture site. Intra-operative blood loss was 120 cc, requiring a transfusion of two units of PRBC, and the surgery was done in 4.5 hours. A posterior half-cylinder spica mold was also placed, and the patient was allowed toe-touch weight bearing with crutches.

Radiographs at three months post-op showed callus formation but with a varus angulation of 10 degrees.

At six months post-op, the fracture was united on radiographs, and the patient was able to ambulate with ease and with full range of motion despite the initial varus angulation (Figure 4).

**Figure 4.** ***Case 2***. Radiographs at six months post-op show union on both fracture sites and equal femur lengths.


**Figure 5.** ***Case 3***. Radiographs at six months post-op show radiographic union, frontal view **(A)**, lateral view **(B)**.

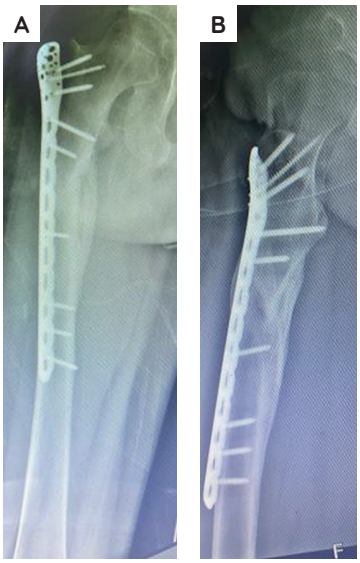


**Figure 6.** ***Case 4***. Radiographs at six months post-op: fracture has united, frontal view **(A)**, lateral view **(B)**.

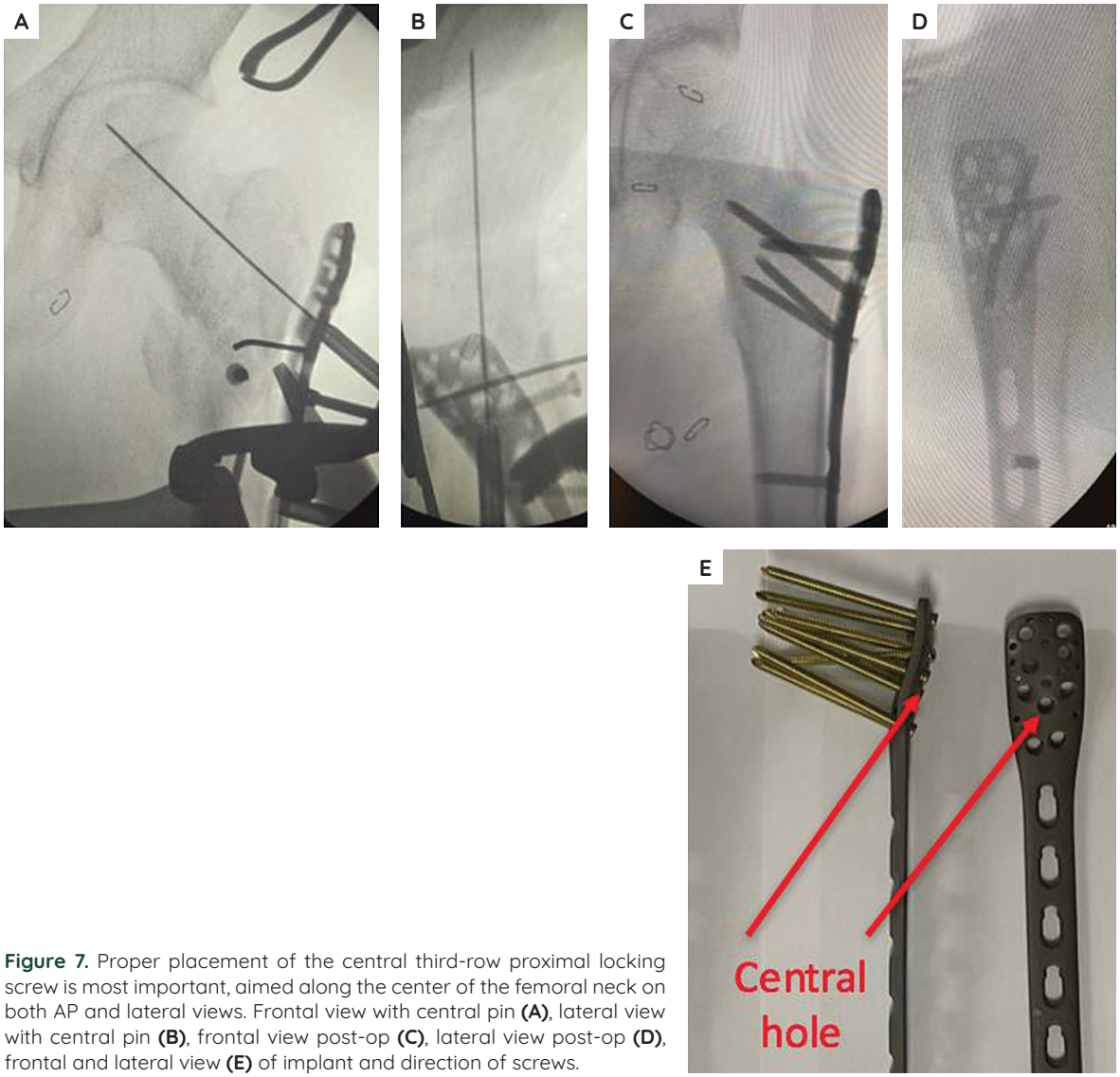


**Figure 7.** Proper placement of the central third-row proximal locking screw is most important, aimed along the center of the femoral neck on both AP and lateral views. Frontal view with central pin **(A)**, lateral view with central pin **(B)**, frontal view post-op **(C)**, lateral view post-op **(D)**, frontal and lateral view **(E)** of implant and direction of screws.

## DISCUSSION

Management of subtrochanteric fractures in children poses a problem due to the innate instability and increased stress at the subtrochanteric area, and the need to avoid disrupting greater trochanter physis, which contributes 30% of the femur's growth, and 15% of the overall length of the lower extremity.[5]

The pre-bent curve of the PHILOS plate designed for the adult proximal humerus nicely corresponds with the contour of the pediatric patients' proximal femur, which greatly assisted in providing anatomic reduction throughout the length of the entire femur. Its central locked screw angulation of 130 degrees is also placed well into the center of the femoral neck, on both AP and lateral views.

Another benefit of the PHILOS plate was its length; the longest pediatric proximal femur locked plate available in our institution fell short, compared to the 26 cm of the longest PHILOS plate. The overhang or wiper noted on the anterior-distal femur due to the length of the plate and femoral bowing was insignificant, and there was no implant prominence appreciated clinically.

Comparing the adult proximal femur locking plate and the PHILOS plates, the width of the PHILOS plate better accommodates the width of the pediatric bone among the age range of our patients 8-14 years old. And since there are more screws with varying directions in the PHILOS plate than the adult proximal femur locking plate (9 vs 5), the PHILOS plate is more forgiving and flexible.

The most important step in these surgeries is the proper placement of the central third-row proximal locking screw, aimed along the center of the femoral neck on both AP and lateral views (Figure 7A and 7B). The first most proximal row is usually left empty because these screws angulate outward from the plate, usually beyond the width of the cortical bone (Figure 7C). The second reason why the most proximal row is left empty is that it usually coincides with the greater trochanteric physis and is avoided to prevent physeal injury.

**Table 1.** Demographic profile of patients and PHILOS plate used in each case

| | Age (years) | Sex | Weight (kg) | Days to surgery | Fracture length (cm) | PHILOS size (hole) | Intra-op Blood Loss (cc) | Harris Hip Score 6 mos |
|---|---|---|---|---|---|---|---|---|
| *1* | 8 | M | 38 | 12 | 9.5 | 12 | 700 | 91 |
| *2* | 9 | F | 32 | 7 | 8 | 12 | 500 | 91 |
| *3* | 14 | M | 45 | 15 | 7 | 10 | 800 | 88 |
| *4* | 13 | M | 48 | 26 | 3.5 | 10 | 120 | 91 |

The placement of at least four proximal locking screws is deemed sufficient for maintaining stability.

A full open incision was made in all of the cases due to the long extent of the subtrochanteric fractures averaging 7 cm (range 3.5–9.5 cm) requiring placement of lag screws (Table 1). In hindsight, a minimally invasive plate osteosynthesis (MIPO) technique could have been attempted, to decrease blood loss.

All patients were able to stand full weight bearing by three months post-op, and all fractures united as patients were able to ambulate without difficulty by six months post-op. There was no leg length discrepancy in all cases, and the range of motion for the hips and knees was full and equivalent to the contralateral limb. There were no cases of infection, no complaints of hardware prominence, nor was there a desire from the patients to have the implants removed.

At six months postoperatively, one patient still presented with a slight limp during ambulation; perhaps since this patient was non-compliant with physical therapy and gait retraining. Harris Hip scores at six months post-op were excellent with an average of 90.25 (88–91).

The results of our study are comparable with the largest case series of Gogna et al., in 2014, which studied eight children aged 10–16 years old in terms of union, absence of infection, and excellent Harris Hip scores on final follow-up. Our study differs in that two of our four cases were from a younger age group, ages 8 and 9, and that the subtrochanteric fractures in our study were all comminuted and longer, averaging 7 cm. This shows that the use of the PHILOS plate also yields favorable outcomes in younger patients and complex fracture patterns.

## CONCLUSION

We conclude that the PHILOS plate is a viable option in the management of long, comminuted subtrochanteric femur fractures in the pediatric population because it can accommodate the narrow width of the proximal femur cortical bone while providing adequate stability needed in this area of high stress.

Compared to previous literature on the topic, our patients included younger patients ages 8 and 9, and longer, more complex comminuted subtrochanteric fractures up to 9.5 cm in length. No screws violated the greater trochanter physis in all our cases. The authors recommend that more cases be done to add to the growing body of knowledge regarding the matter and that an MIPO technique be attempted to minimize blood loss.

## ETHICAL CONSIDERATION

Patient consent forms were obtained before manuscript submission.

## STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

## AUTHORS DISCLOSURE

The authors declared no conflict of interest.

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