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Pediatric pathological subtrochanteric fracture treated with an adult proximal humerus polyaxial locking plate: A case report

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Abstract

Pediatric subtrochanteric fractures are relatively rare. There are some surgical options with various plate techniques. Here, we report the first description of a pediatric pathological subtrochanteric fracture treated with an adult proximal humerus polyaxial locking plate and describe the good clinical outcomes achieved. A 10-year-old boy had a pathological subtrochanteric fracture. A non-contact bridging proximal humerus osteosynthesis plate was used. Although this is designed for the adult proximal humerus, its size and shape were considered to fit the pediatric proximal femur. In addition, this is a polyaxial locking plate with a choice of screw insertion directions. During surgery, it was possible to determine an appropriate plate installation position and screw direction in consideration of the location of pathological lesions, the bone shape, and the femoral neck angle. Twelve months postoperatively, the fracture was healed, and pathological lesion consolidated without obvious growth failure.

Keywords

Pediatric subtrochanteric fracture, polyaxial locking plate, proximal humerus plate

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Introduction

The frequency of proximal pediatric femur fractures is relatively rare, occurring in 4%–17% of all pediatric femoral fractures.[1,2] This proximal femur fracture could be caused by severe, high-energy forces, such as traffic accidents. If this fracture is caused by an insignificant force, an underlying etiology, such as a pathological lesion of the proximal femur, is suggested.

Displaced pediatric proximal femoral fractures are often treated with open reduction and internal fixation (ORIF) or external fixation.[2,3] In children, the femoral head and greater trochanter have physis. If physeal injury occurs during surgery, subsequent growth disturbances can be induced. Therefore, damaging the physis during surgery should be avoided in children aged <10 years.[4] Some surgical options to treat pediatric subtrochanteric fracture, using pins, screws, external fixation, and implants such as plates for trauma, elastic nails and rigid nails, are available for internal fixation, but there are no specific definitive implants.[2,3,5,6] Here, we report a case of a pediatric pathological subtrochanteric fracture treated with an adult proximal humerus polyaxial locking plate and describe the good clinical outcomes achieved.

Case

A previously healthy 10-year-old boy was admitted to our hospital for an injury to his left hip while playing in a schoolyard without significant trauma. Radiographs revealed a subtrochanteric fracture of the left femur with physis in the femoral head and greater trochanter. The fracture occurred

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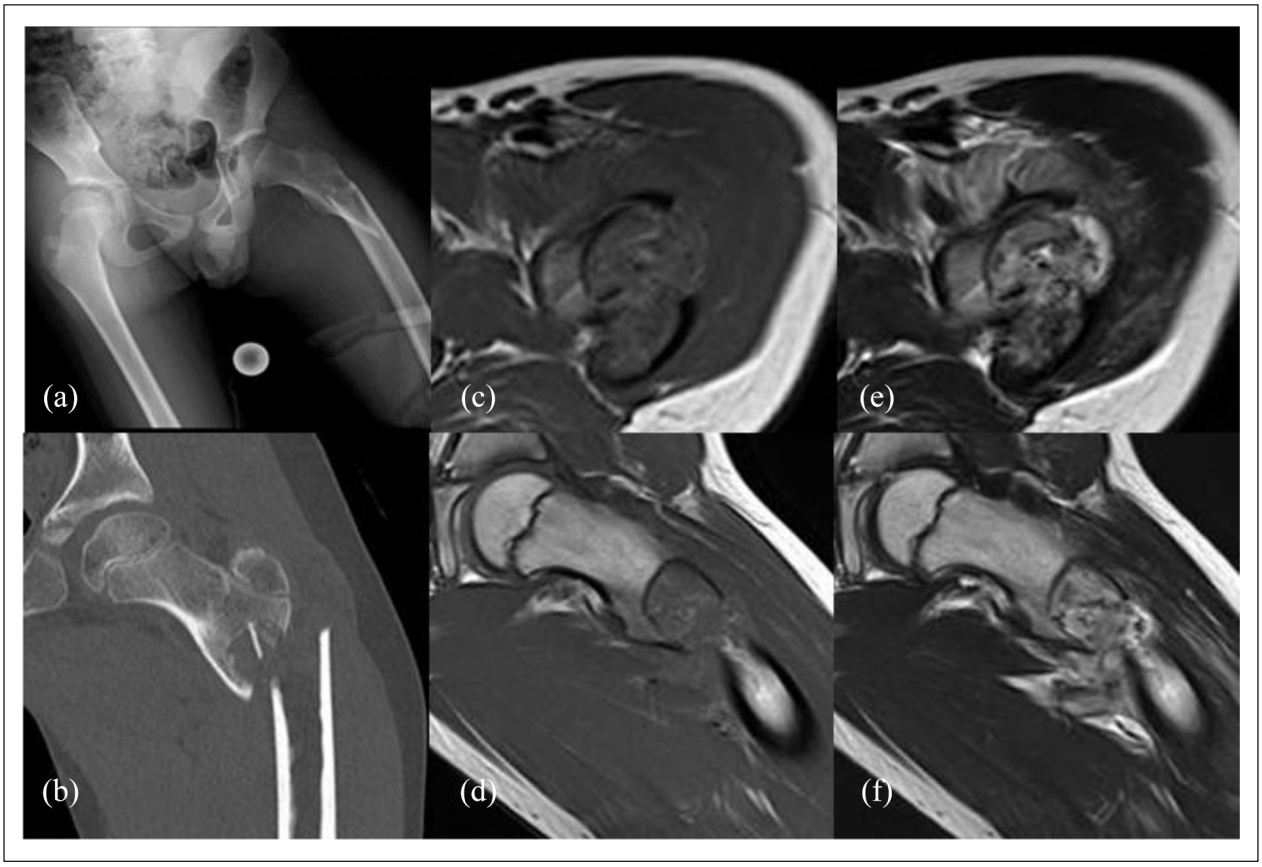

Figure 1. (a) Radiograph showing a subtrochanteric fracture of the left femur with a well-defined geographic lucent lesion that indicated a pathological lesion at the fracture site. (b) Computed tomography scan showing a centrally located well-demarcated metaphyseal lesion with cystic lytic expansion. A bony fragment is observed, suggesting a fallen fragment sign. (c–f) Magnetic resonance images showing low-intensity lesions on T1-weighted (c and e) and T2-weighted (d and f) images (c and e: axial views and d and f: coronal views). Heterogeneity of the lesion is noted with patchy signal changes within the bone marrow lesion.

through a well-defined geographic subtrochanteric lucent lesion, which indicated a pathological lesion (Figure 1(a)). Computed tomography (CT) showed a centrally located well-demarcated metaphyseal lesion with cystic lytic expansion (Figure 1(b)). A bony fragment was observed, suggesting a fallen fragment sign. Magnetic resonance imaging (MRI) showed a low-intensity lesion on T1- and T2-weighted images. There was heterogeneity of the lesion with patchy signal changes within the bone marrow lesion (Figure 1(c)–(f)). Because the MRI was taken after the fracture, the possibility of the malignancy could not be determined, and a bone biopsy was scheduled.

At the time of bone biopsy, the specimen was confirmed under fluoroscopy, and a sample was collected. Macroscopically, no apparent abnormalities were found, and the lesion was filled with fluid and hematomas. Microscopically, no malignant findings such as atypical cells were found, and the lesion was diagnosed as a simple bone cyst. Finally, the possibility of malignancy was ruled out, and we scheduled ORIF with plate fixation.

A non-contact bridging proximal humerus osteosynthesis plate (NCB-PH™) (Zimmer Biomet, Warsaw, IN, USA) was selected for internal fixation. Although this is designed for the adult proximal humerus, it was considered suitable for the proximal femur in children due to its size and shape. In addition, because this is a polyaxial locking plate, it was thought that damages of physis could be prevented because the direction of screw insertion could be selected.

Reduction was obtained using a fracture table and confirmed under fluoroscopy. A lateral approach was used in this study. After temporarily fixing the fracture to maintain the reduction using cable to crimp the bone fragments together, the plate was placed on the lateral side of the proximal femur. The plate position was selected to ensure that as many long screws as possible could be inserted without damaging the proximal femoral physis (Figure 2(a) and (b)). For the proximal part, three locking screws were inserted to stabilize the proximal bone fragment, while penetrating the lesion, which spared the proximal femoral physis. For the distal part, three screws were inserted from the distal bone

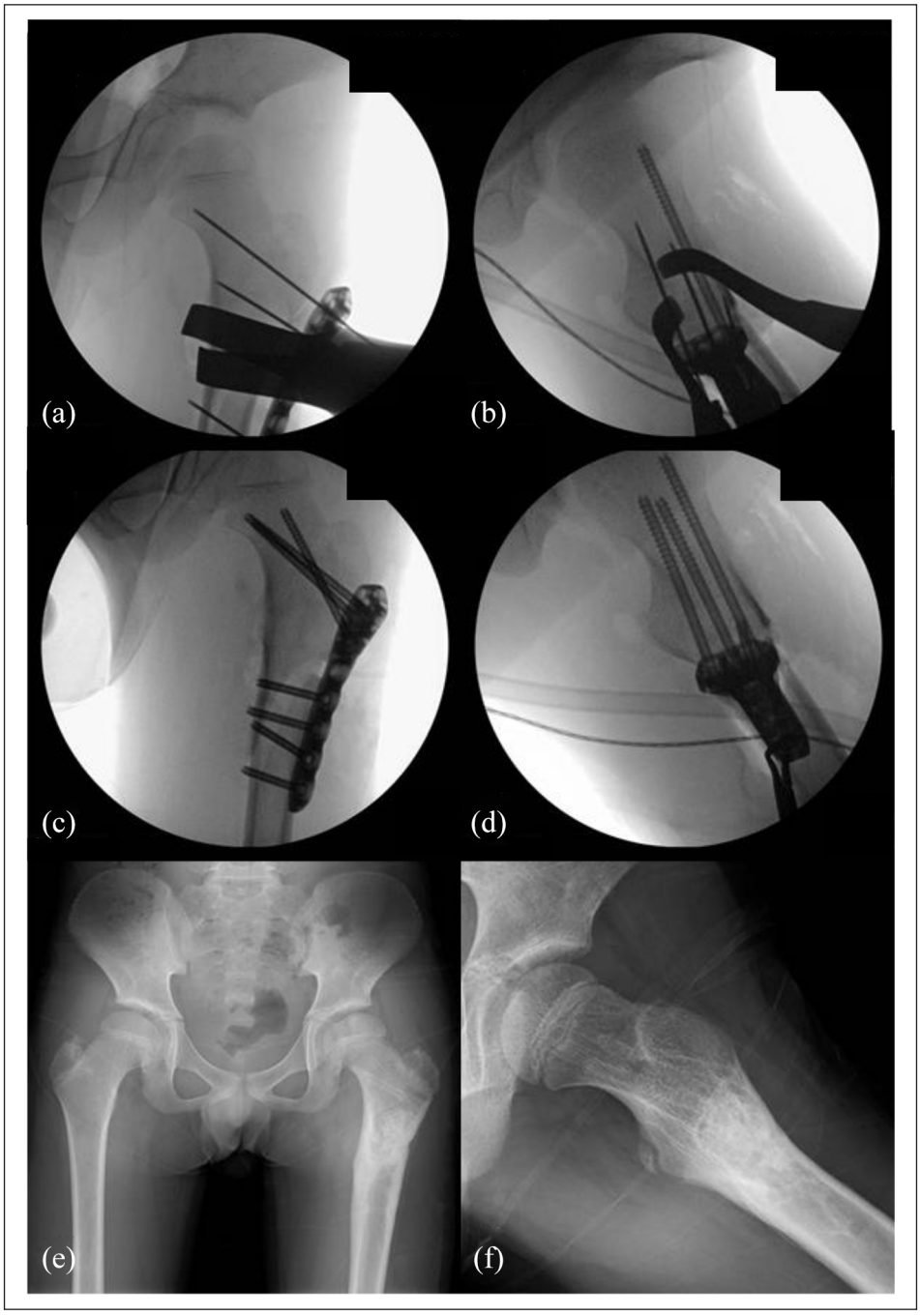

Figure 2. (a and b) Fluoroscopic images (a: anterior posterior view and b: lateral view) confirming the position where the plate could be installed for as many long screws as possible could be inserted without damaging epiphysis. (c and d) Fluoroscopic images (c: anterior posterior view and d: lateral view) showing the plate and screw installation positions. Three screws are inserted to stabilize the proximal bone fragment, while penetrating the pathological lesion without damaging the epiphysis. (e and f) Radiographs (e: anterior posterior view and f: lateral view) at 12 months after surgery showing that the fracture site is fused, and bone formation is observed within the pathological lesion. No obvious growth failure was noted at this time.

fragment to the proximal bone fragment. The most distal screw was inserted bi-cortically into the distal bone fragment (Figure 2(c) and (d)). The cable used for temporarily fixation was removed. Cyst curettage and bone grafts were not performed due to invasiveness.

Postoperatively, non-weight-bearing was applied to the affected limb for 4 weeks. Thereafter, partial weight-bearing was initiated, and full weight-bearing was allowed at 6 weeks after surgery. Three months after surgery, the fracture appeared healed. Six months after surgery, the implant was

removed. Twelve months postoperatively, the fracture was healed and the pathological site was consolidated, and no obvious growth failure was observed (Figure 2(e) and (f)). The patient was asymptomatic, had full range of motion in his hip, and was able to participate in all previous activities without pain and limitations.

Discussion

Pediatric subtrochanteric fractures are relatively rare. Subtrochanteric fractures are often seen in pathological lesion, such as bone cysts or tumors. There are some surgical options including ORIF with various plate techniques. There are only a handful of case reports where an adult humeral locking plate was used to treat a pediatric subtrochanteric fracture, and to the best of our knowledge, this is the first description of a pediatric pathological subtrochanteric fracture that was treated with an adult proximal humerus polyaxial locking plate. Although rare, it is important to be recognized this as one of the treatment options.

To treat a proximal femur fracture in children, elastic nails, which are smooth pins, are selected for ORIF.[7,8] However, in our case, the fracture line extended to the subtrochanteric region, indicating an unstable fracture, and it was thought that the proximal fragment did not have enough space for the insertion of nails of appropriate length to stabilize it. Considering this, it was thought that elastic nails alone would need to penetrate the physis in order to provide sufficient fixation.

The use of plates for adult proximal femur fractures was not selected for the following reasons: (1) the direction of the proximal screw was not appropriate for the direction of the femoral neck in children; (2) since sufficient short screws were not available, the screw could penetrate the physis; and (3) a large bone hole should be created in the neck of the femur because of the thick diameter of the screws. The LCP PEADIATRIC HIP PLATE SYSTEM is designed for osteotomy, and there are only two screws that can be inserted in the direction of the femoral neck, and it is impossible to adjust the direction of screw. For these reasons, we did not select this plate.

Previously, adult proximal humerus locking plates[5,6] and adult lower-extremity periarticular locking plates[9] have been used for pediatric subtrochanteric fractures. Since these are monoaxial locking plates, it is impossible to adjust the direction of screw insertion. In this case, it was considered that the placement position of these monoaxial locking plates could not be adjusted due to the position of pathological lesion, bony shape, and femoral neck angle of the patient, so that the screws could penetrate the physis when these plates were selected.

Therefore, we chose a plate for an adult proximal humerus polyaxial locking plate. The advantage of this plate is as follows: this is a locking plate, which act as an internal external fixator and confer angular and axial stability; locking plate could be useful in osteoporotic and pathologic bone; the screw diameter is small (3.5 mm); and the screw length variation is sufficient from as short as 20–50 mm, which is useful for a small bony shape in children. In addition, the most important advantage is that this plate is polyaxial; the direction of screw insertion could be freely selected up to 15°. Therefore, it is possible to select an appropriate plate installation position and screw direction in consideration of the location of pathological lesions, the shape of the bone, and the angle of the neck of the femur.

One of the concerns about this plate is its mechanical strength. This plate is designed for the humerus, and may fail when the load is applied to the affected limb. Another disadvantage is the length of plate. This is the longest plate of its type, but still only one screw could be inserted bi-cortically into the distal bone fragment. Therefore, non-weight-bearing was necessary at early postoperative period. Partial-weight-bearing was applied after the callus formation was confirmed. Currently in Japan, there are no approved implants specifically for pediatric proximal femoral fractures. It is difficult to select an appropriate implant in such cases. In this case, we decided to select this implant and final results were favorable.

This is the first description of a pediatric pathological subtrochanteric fracture treated with an adult proximal humerus polyaxial locking plate. Although rare, it is important to be recognized this as one of the treatment options.

Conclusion

We report a case of a pediatric pathological subtrochanteric fracture treated with an adult proximal humerus polyaxial locking plate, along with the good clinical results that were achieved. The advantage of this polyaxial plate is that many screws can be inserted at appropriate positions and angles without damaging the physis. This approach is considered useful for pediatric pathological subtrochanteric fractures.

Declaration of conflicting interests

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Ethical approval

Our institution does not require ethical approval for reporting individual case.

Informed consent

Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article.

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