

Femoral head wedge resection for the treatment of avascular necrosis of the femoral head after pediatric femoral neck fracture: a case report

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This research focuses on femoral head wedge resection for the treatment of avascular necrosis (AVN) of the femoral head. A 9-year-old girl presented to the emergency room complaining of right hip pain that occurred after a pedestrian car accident. After 8 months of internal fixation using cannulated screws for Delbet-type 2 fracture of the femoral neck, AVN of the femoral head developed in the patient. Even though valgus-derotation-extension intertrochanteric osteotomy was performed for the treatment of AVN, it progressed further and femoral head wedge resection was performed to recover the femoral head sphericity. After 3 years of follow-up, radiograph results showed appropriate and satisfactory congruency and containment. This research shows that the treatment of

AVN of the femoral head using femoral head wedge resection is an effective method that can yield excellent results. *J Pediatr Orthop B* 27:283–288 Copyright © 2018 The Author(s). Published by Wolters Kluwer Health, Inc.

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Introduction

Femoral neck fracture in children is a very rare event and comprises less than 1% of all pediatric fractures [1]. The reason for its rarity is that the femoral neck in children is covered with a durable periosteum, which makes it strong and thick [2]. Therefore, a femoral neck fracture in children signifies high-energy damage and its treatment requires caution [2].

Not only is this type of fracture rare, but it also has a high rate of complications [2,3]. Varus angulation, delayed union, and nonunion are related to surgical treatments, whereas avascular necrosis (AVN), premature closure of the epiphyseal plate, and lower limb paralysis are related to nonsurgical treatments. Out of these complications, which affects the final outcome the most and also occurs most frequently, is AVN of the femoral head [4–6]. If AVN of the femoral head occurs, the subchondral bone weakens and fracture occurs. Subchondral fracture of the femoral head (crescent sign) causes pain and articular rigidity. Also, it pathologically causes flattening of the femoral head, and thus deformation of the femoral head and arthritis may develop [7,8].

If AVN occurs after femoral neck fracture, appropriate treatment is needed according to the age of the patient or

the degree of necrosis to minimize deformity of the femoral head. Primarily, containment treatment (the use of a brace or varus osteotomy) or valgus intertrochanteric osteotomy can be performed [9]. Children with AVN of the femoral head might show abnormal painful hinge movement of the hip, which is because of impingement of the protruded anterolateral osteocartilaginous hump of the deformed femoral head against the acetabular rim. Valgus femoral osteotomy could be indicated in this condition as it moves the ‘hump’ on the femoral head further away from the acetabular margin, thus alleviating the hinge abduction, and effectively preventing the progression of femoral head deformity and arthritis [10].

In children who are older than 10 years, if widespread AVN of the femoral head occurs, distraction arthroplasty rather than osteotomy may be performed, but the treatment outcome is not very favorable in most cases, and artificial hip replacement or articular fusion may need to be considered [11–13]. However, taking into account the fact that the patient was not yet an adult, even these options were not feasible.

We report a case of femoral head AVN occurring after a pediatric femoral neck fracture that was treated with femoral head wedge resection and showed good results.

Case presentation

A 9-year-old girl presented to the emergency room complaining of right hip pain that occurred after a pedestrian car accident. She was hemodynamically stable

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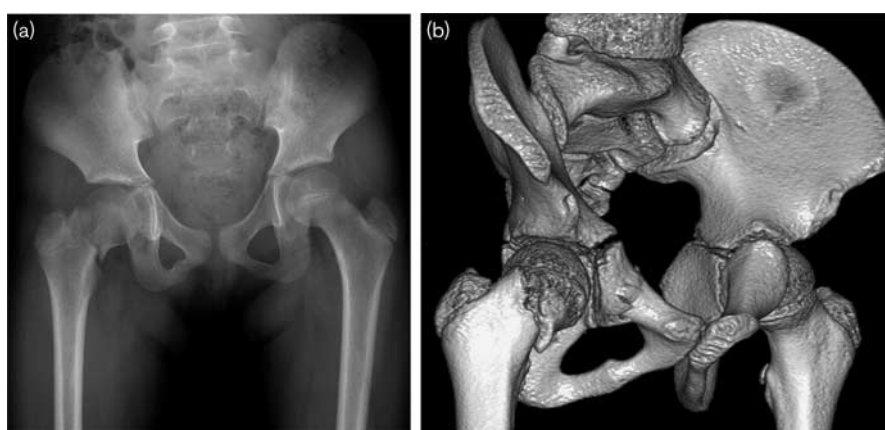
and no other accompanying damage was observed. The hip radiography and computed tomography scans taken in the emergency room showed a displaced Delbet type 2 fracture of the right femoral neck (Fig. 1). Emergency surgery was performed under anesthesia, and closed reduction and internal fixation using a cannulated screw were performed (Fig. 2a). A cast was placed for 6 weeks, and bone union was achieved 3 months after the surgery (Fig. 2b).

Eight months after the surgery, the patient complained of right hip pain that worsened with activity, and the radiograph showed femoral head depression accompanied by

AVN (Fig. 2c). The metal screw was removed 1 year after the surgery, but the AVN of the femoral head continued to progress (Fig. 2d).

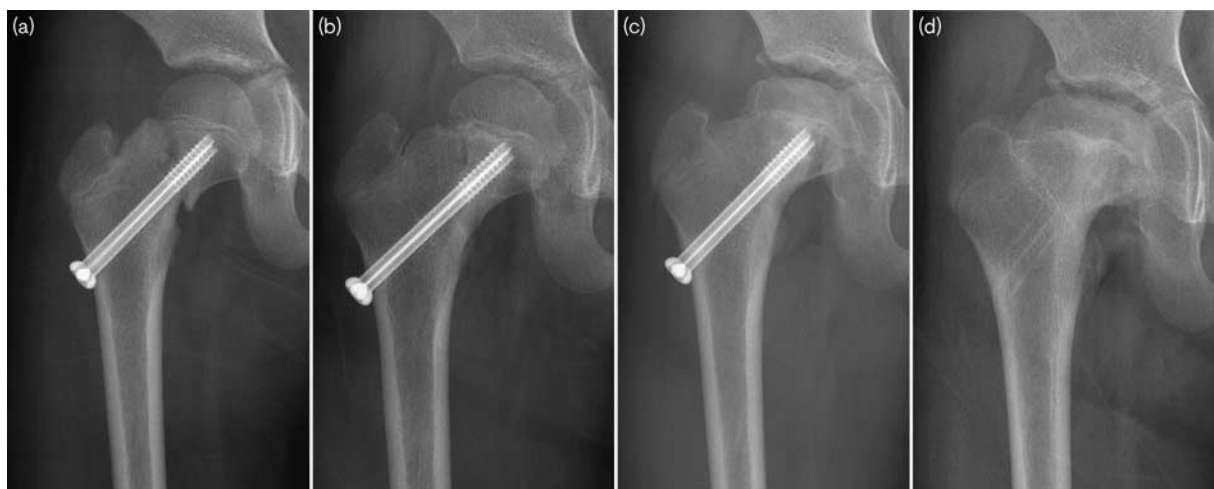
Pain of the hip joint continued to worsen; therefore, a second surgery was scheduled and an arthrogram was performed under anesthesia. The hip joint showed hinged abduction, which leads to the best congruency in the adduction–internal rotation position. Valgus–derotation–extension intertrochanteric osteotomy, which can best correct the hip congruency, was performed (Fig. 3). After the surgery, the pain was temporarily alleviated, but deformation of the joint continued to progress, and

Fig. 1



(a) Bilateral pelvic anteroposterior radiograph taken in the emergency room. A right femoral neck fracture is observed. (b) The three-dimensional computed tomography shows translocation and angular deformity of the right femoral neck fracture.

Fig. 2

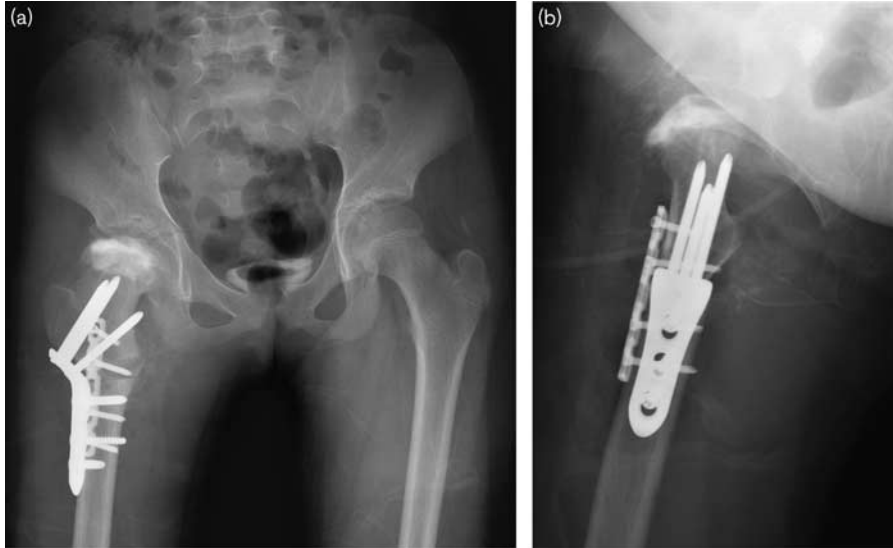


(a) Hip radiograph taken immediately following surgery. Internal fixation with two cannulated screws was performed without damaging the epiphyseal plate. (b) The hip radiograph taken 3 months after surgery shows bone union of the fracture site. (c) Eight months after surgery, femoral head depression with avascular necrosis was observed. (d) One year after surgery, femoral head avascular necrosis had progressed and the metal screw was removed.

2.5 years after injury, she complained of pain after several minutes of walking. She showed an antalgic gait pattern. On physical examination, hip abduction was 20° and hip internal rotation in the prone position was 15°. The

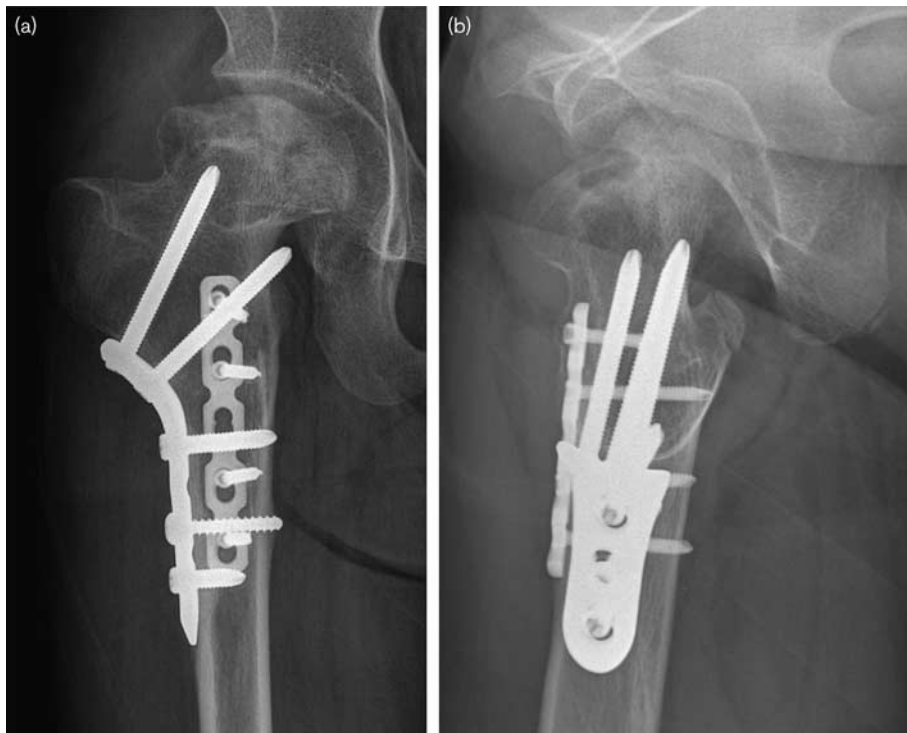
follow-up radiograph showed more progression of the femoral head depression, because of which the sphericity of the femoral head was lost and a bump had formed on the anterolateral portion of the head (Fig. 4).

Fig. 3



(a) Bilateral pelvic anteroposterior radiograph taken after valgization-derotation-extension osteotomy. (b) Translateral view of the right hip taken immediately after the second surgery.

Fig. 4



Right pelvic anteroposterior radiograph taken 1 year after the second surgery (a) and the translateral view (b).

A third surgery was performed to recover the sphericity of the femoral head and to increase the range of motion. Surgery was performed in the semilateral position with the sandbag under the ipsilateral hip. We used an anterolateral approach (Watson–Jones) for wedge resection. A T-shaped incision was made for capsulotomy. While abducting-adducting and rotating the joint, we first assessed the pathologic shape of the femoral head. There was a longitudinal fissure along the lateral articular surface of the femoral head, denuded of normal joint cartilage, which was created by impingement of the large femoral head against the lateral margin of the acetabulum.

Wedge of the bone was resected including the area of longitudinal fissure (Fig. 5a and b). Then, the base of the lateral bump was greenstick fractured to be repositioned in the previously fissured area, which reduced the size of the femoral head. We checked the adequacy of wedge excision for the hip joint to move without impingement between bump on the femoral head and the acetabular edge or hinged abduction that the femoral head is hinged

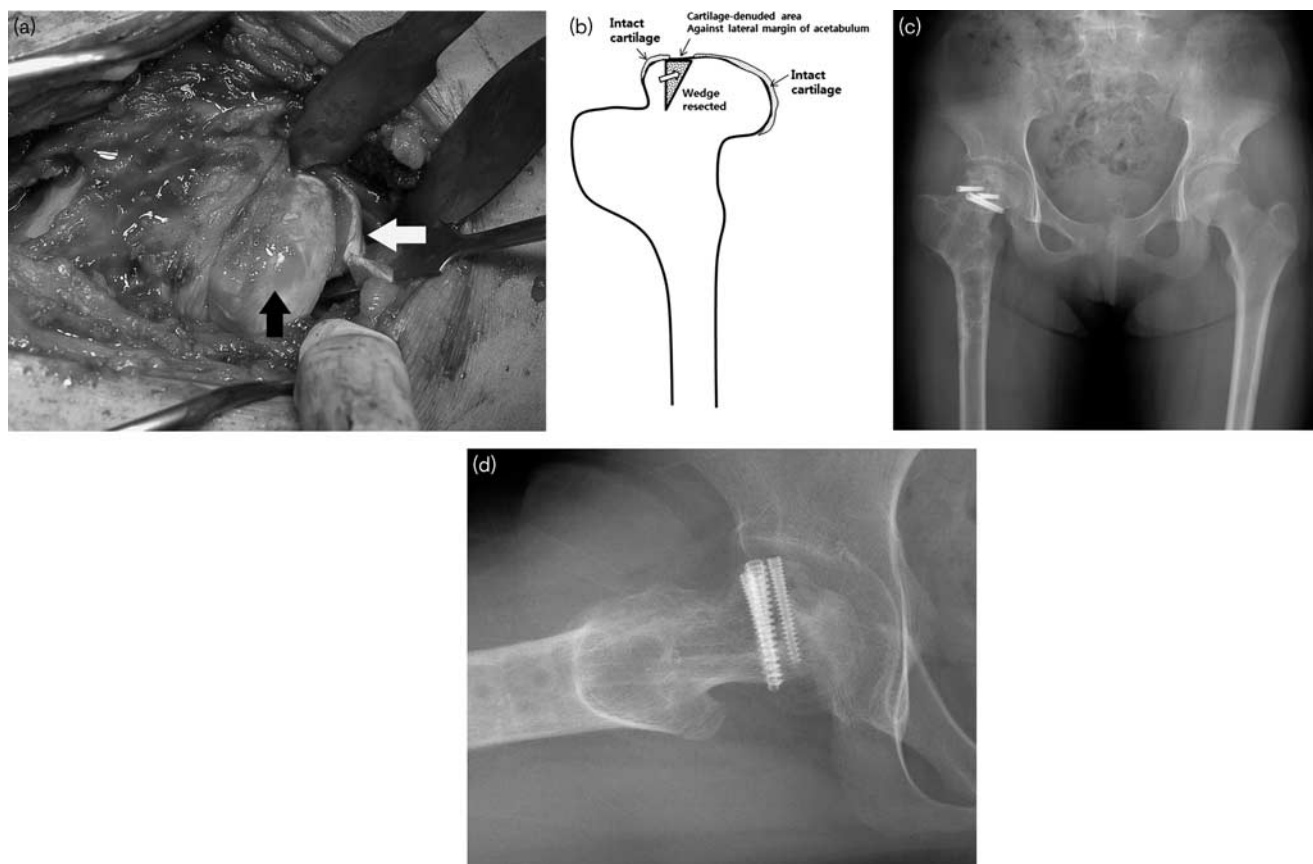
to the acetabulum and the medial joint space widening occurs.

The empty space caused by the resection was filled so that sphericity of the femoral head was recovered, and internal fixation was performed using a headless screw. The radiographs taken after the surgery showed recovery of the sphericity of the femoral head (Fig. 5c and d).

After the wedge resection, pain and limping decreased rapidly, and the patient was satisfied with the surgical results. Hip range of motion increased and was painless postoperatively. Hip abduction and internal rotation improved to 40°. She could sit crossed-legged on the floor comfortably. The patient does not complain of pain or limping during the 3 years follow-up after the last operation.

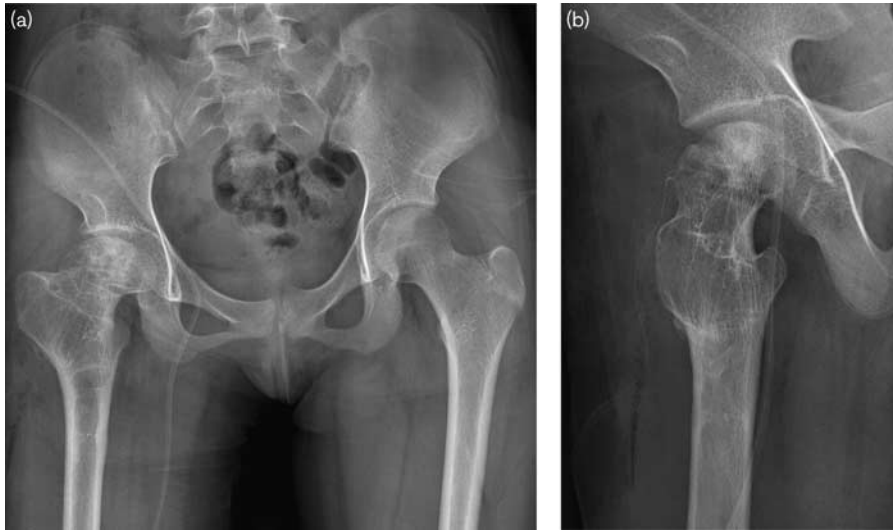
The metal screw was removed 2 years after resection, and the patient did not complain of any motor disturbance or pain. Also, the follow-up radiograph showed appropriate and satisfactory congruency and containment (Fig. 6).

Fig. 5



(a) Picture taken during surgery of the right hip joint. The black arrow is the femoral head and the white arrow is the resected bone fragment. (b) The white arrow is the direction of movement of the lateral fragment. (c) Bilateral pelvic anteroposterior radiograph taken after femoral head wedge resection. (d) Frog leg view of the right hip taken after femoral head wedge resection.

Fig. 6



(a) Bilateral pelvic anteroposterior radiograph taken 1.5 years after femoral head wedge resection and removal of the metal screws. (b) Translateral view of the right hip after metal screw removal.

Discussion

Reports of femoral head AVN vary, at 14–47% [2]. The risk factors of femoral head AVN after a femoral neck fracture include age, degree of fracture displacement, fracture severity, time to surgery after injury, and method of fixation [4,14]. Of these, the most important factor is the severity of vascular damage at the time of injury. In adults, the intraosseous blood vessels may provide blood supply to the femoral head, but in children, the vessels cannot cross the open physis; therefore, blood supply is easily cut off if a hip fracture occurs [2].

According to previous reports, the occurrence of AVN after femoral neck fracture is an important factor that affects prognosis, and the outcome is usually unsatisfactory in patients who have the condition [2,15]. However, unlike in adults, the number of treatment options is limited in children. Nonsurgical methods cannot stop progression. A hip replacement or articular fusion in patients with an open physal plate can later cause problems in development or in outer appearance. Therefore, there are about two surgical options that can be performed. The first is a valgus intertrochanteric osteotomy [9]. This involves shifting the weight-bearing surface to another area that is not affected by AVN, and can be attempted if the extent of necrosis is not too wide. However, as in this case, if widespread necrosis occurs, there is a limit to the normal surface and collapse cannot be prevented. In this case, despite the fact that valgus osteotomy was performed, necrosis led to a collapse and the formation of a bump, which restricted the range of motion and aggravated pain and required additional treatment. The second option is a trap-door operation (subchondral bone grafting for segmental collapse) [16].

The limitations of this method are that if deformity because of collapse is severe, the surgical method may become more difficult to perform, and in areas that have poor circulation, the bone graft may not heal properly.

The femoral head wedge resection performed in this case, unlike other surgical methods, has the advantage that it can be performed even in cases with widespread necrosis, taking into account the degree of femoral head deformity. The necrotic depressed area collapsed area of the femoral head due to osteonecrosis can be directly removed and an additional bone graft can be performed in the remaining area. Also, the remaining undamaged articular surface can be used so that the progression of degenerative arthritis can be delayed, and other surgical methods such as intertrochanteric osteotomy can be performed concomitantly. Previous methods such as cheilectomy lead to exposure of the subchondral bone, not the articular cartilage after resection of the bump; therefore, it can be considered a type of salvage operation, but in the femoral head wedge resection (wedge resection-greenstick fracture-fixation) performed in this case, the femoral head remains covered by the articular cartilage, and thus is expected to have a better long-term prognosis.

Rarely, femoral head osteotomy has been reported in past studies. Siebenrock *et al.* [17] performed head reduction osteotomy in patients with Legg–Calve–Perthes disease. They used the posterior approach and trochanteric osteotomy. A periosteal flap was made to preserve the relevant branch of the medial circumflex artery and osteotomy was performed in the necrotic depressed area. Also, complete osteotomy was performed on the lateral

fragment. This altered the anatomy of the femoral neck. In a study by Burian *et al.* [18], the anterolateral approach was used and periosteum on the anterior aspect of the neck was incised. However, the wedge resection in this study was different from previous studies. We used the familiar anterolateral approach and the femoral head was not dislocated for the procedure. The wedge osteotomy was performed in the bump area and the lateral fragment was repositioned with a greenstick fracture. This had the advantage that bony blood flow through the neck was not completely blocked and postoperative immobilization was minimal. Also, there was no other damage that could affect vascularity after capsulotomy.

Many different types of surgery are being attempted in the treatment of femoral head AVN occurring after a pediatric femoral neck fracture, but there is still no consensus on the optimal treatment method [9]. However, the femoral head wedge resection performed in this case is the only surgical procedure that can overcome the disadvantages of other surgeries the disadvantages of other surgeries. This method can be performed concomitantly or additional to other surgeries, and can help achieve appropriate congruency and containment of the hip joint.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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