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CASE REPORT

Use of Gamma locking nail® in tri-planar osteotomy in bilateral severe slipped upper femoral epiphysis: a case study and literature review

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Abstract
Introduction Slipped upper femoral epiphysis (SUFE) is a common condition affecting adolescent boys and girls. It is classified as acute, chronic or acute on chronic. The slip can be mild, moderate or severe.
Materials and methods We present a case of chronic severe SUFE in a 16-year-old male with significant fixed bilateral deformities requiring osteotomy of proximal femur and stabilisation with short locking Gamma nail®. To our knowledge, this device has not been used in stabilisation of osteotomies in chronic SUFE.
Conclusion The purpose of this paper is to describe the results of our fixation method and also to increase the awareness in orthopaedic surgeon about the usefulness of Gamma locking nail® in these difficult situations.

Keywords Femoral epiphysis · Corrective osteotomy · Gamma nail · Slipped capital femoral epiphysis · Paediatric hip

Introduction

Slipped upper femoral epiphysis (SUFE) is a condition occurring in adolescents with a reported incidence of two cases per 100,000 [6]. It affects boys more commonly than girls. The usual age of presentation ranges from 11 to 15 years; mean age of diagnosis is 13.5 years for boys and 12.0 years in girls. The term SUFE is a misnomer since the epiphysis is held in acetabulum by ligamentum teres and the metaphysis rolls forward. The slip occurs through the hypertrophic zone of the growth plate. In a vast majority of cases, the aetiology is unknown. Multiple theories have been proposed, and the condition may be caused by mechanical or biochemical factors. Mechanical factors include obesity, increased femoral retroversion and physeal obliquity. They all act by increasing shear stress across the physis leading to slip. Biochemical factors include endocrine disorders (e.g. hypothyroidism, hypogonadism and patients on growth hormone therapy). These factors are associated with widening and weakness of the physis. Testosterone reduces physeal strength, whilst oestrogen increases physeal strength and reduces physeal width. This probably explains why the disease is more common in adolescent boys and extremely rare in girls after menarche. The classic somatotype is an overweight, adolescent boy with the affected foot externally rotated and complaining of limping associated with groin or knee pain [2]. The most consistent examination finding is lack of internal rotation. The usual direction of slip is posterior, which is diagnosed with history, clinical examination and X rays. The initial goal of treatment of acute or acute on chronic SUFE aims at preventing progression of the slip, thus decreasing the risk of late complications. This is commonly performed with in situ fixation using a single percutaneous cannulated partially threaded screw. Complications of the treatment include additional slippage, chondrolysis and avascular necrosis. Osteotomy remains a useful alternative in the treatment of severe chronic SUFE (>50% displacement of the epiphysis). Intertrochanteric osteotomy, as described by Imhauser, is technically a very demanding procedure, but shows excellent outcome in 77% of patients with a slip

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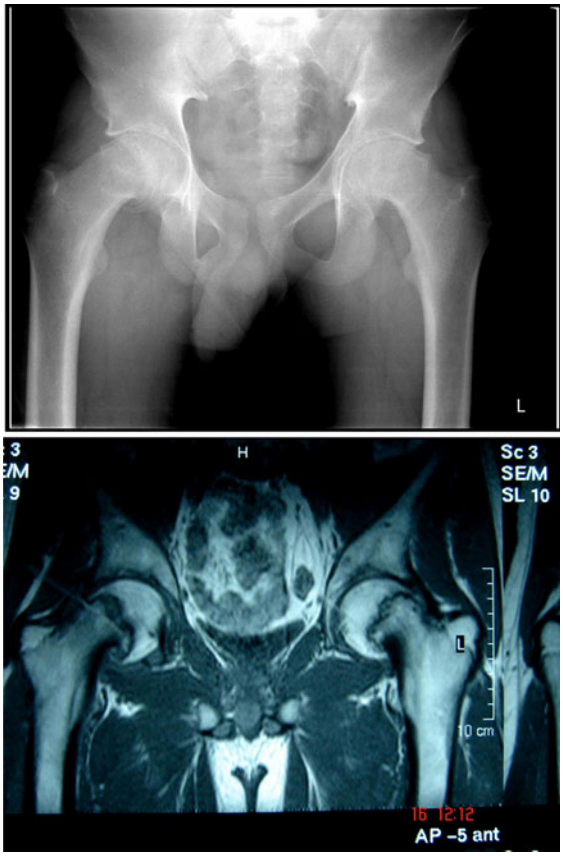

Fig. 1 Plain X-ray and MRI scan of the patient pre-operatively showing AP view of bilateral SUFE

angle of >40° [8]. Different types of hardware to stabilise osteotomy in SUFE have been described in literature with variable outcomes [10]. To our knowledge, most of the corrective osteotomies were stabilised with a 95° bent plate. We present a case of severe SUFE treated with tri-plane intertrochanteric corrective osteotomy, which was stabilised with short Gamma locking nail® (Stryker Trauma GmbH). Gamma nail was introduced in 1985 for treatment of unstable intertrochanteric or subtrochanteric femur fractures. It consists of three main components: a central rod for intramedullary placement, a proximal locking screw for the femoral head and a distal locking screw to prevent rotation. It is in common use now by orthopaedic trauma surgeons for the treatment of femur fractures [7]. Although, Barden et al. [3] in his series used Gamma nail® to fix intertrochanteric osteotomy in osteoarthritic patients, to our knowledge, its use in SUFE has not been described in literature.

Case report

A 16-year-old male presented to us in December 2002 with severe grade II (slip between 30 and 60%) bilateral slipped upper femoral epiphysis. He had a marked fixed external rotation, extension and varus deformity of both hips. His X-ray and MRI showed bilateral SUFE, moderate on the left side and severe on the right side [1] (Fig. 1); a lateral view was not possible due to his fixed deformity.

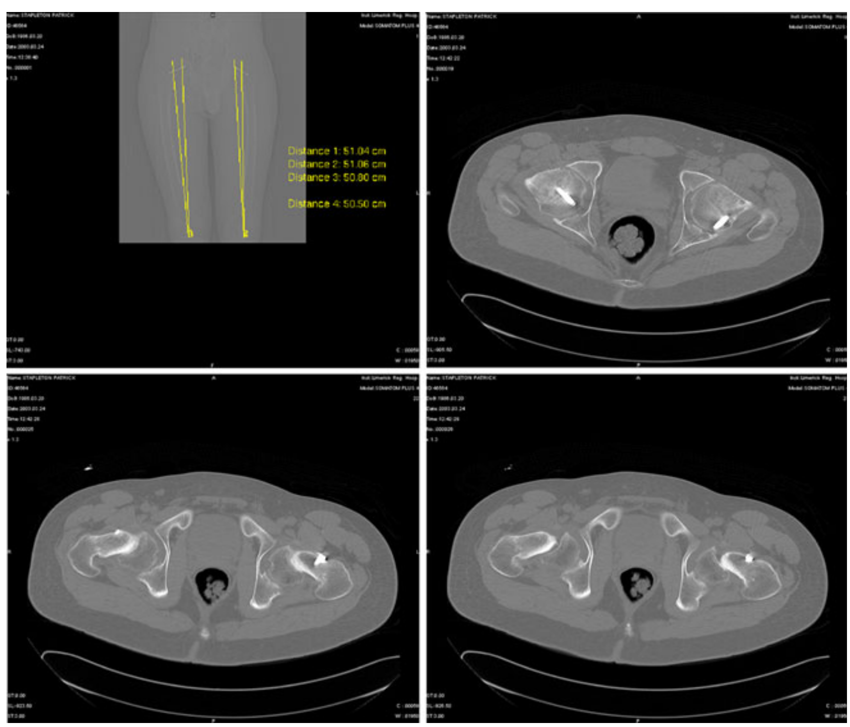

Fig. 2 CT scan of the patient post-pinning. The physis were still open at that stage and not ready for osteotomy

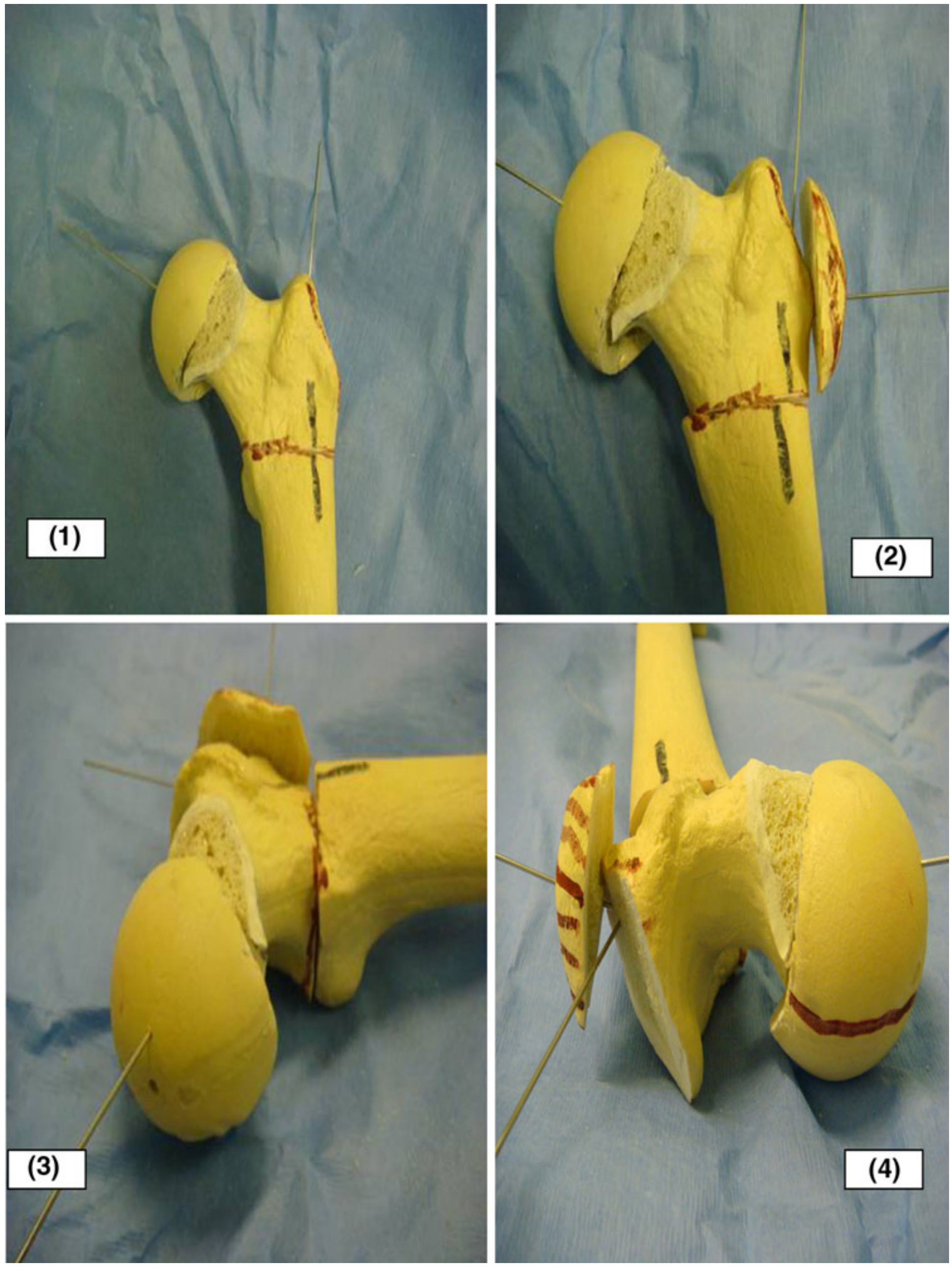

Fig. 3 Shows the different stages of osteotomy on saw bones. *1* Neck cheilectomy and osteotomy of the greater trochanter transverse osteotomy marked. *2* AP view with the deformity corrected by internal rotation of the distal femur. *3* Lateral view with the deformity corrected. *4* Axial view showing the distal femur internally rotated after transverse osteotomy at the level of the lesser trochanter

CT scan showed that both physis were still open. A percutaneous screw fixation in situ was performed the following day. Radiographic screening of the screws in three planes confirmed a satisfactory position (Fig. 2).

At 3 months follow-up X-rays demonstrated completely closed physis. At this stage, the patient was very disabled due to his fixed bilateral hip deformity. He subsequently had a corrective tri-planar osteotomy of his left hip. Under general anaesthesia and lateral decubitus position, a longitudinal incision was made centred on the greater trochanter. The exposure was extended by a shallow trochanteric osteotomy, not involving the piriform fossa. An anterior T-shaped capsulotomy was performed to access the hip joint. Cannulated screw was removed. The remnant of the osteophyte at the femoral neck anterosuperiorly was removed under direct vision (cheilectomy).The femoral head was then placed in its most accommodating position in the acetabulum (external rotation, varus and extension) and an osteotomy was performed at the intertrochanteric plane just above the level of the lesser trochanter. The leg was then brought to its more natural position (internal rotation, neutral flexion and abduction). With the hip position maintained as previously, a secondary osteotomy of the femur was performed to align it parallel with the proximal part (Fig. 3). The alignment was stabilised by introducing a 125° short Gamma nail® down the trochanteric bed. Distal locking was performed using the jig. Chips of bone from the osteotomy site and cheilectomy were used as bone graft and packed in situ. The trochanteric osteotomy was re-attached anterior to its original position by Dall-Miles® cables (Fig. 4).The capsule was sutured followed by layered closure up to the skin. The total blood loss was 650 ml.

During his early post-operative days, he received extensive physiotherapy, consisting of passive range of motion exercises of his hip, continuous passive motion (CPM) and balanced abduction exercise on the beam. On day 10 post-surgery, he was discharged on toe touch weight bearing for 6 weeks followed by partial to full weight bearing as tolerated. A similar procedure was performed on the contralateral hip, 3 months later. Six months after his initial surgery, the Gamma nail® was removed from the left side. The right Gamma nail® was removed 9 months after surgery. Post-removal of metal, he was advised to mobilise from toe touch to partial weight bearing over 6 weeks. Following this, with intensive physiotherapy, he showed excellent progress with return of normal function and nearly full range of motion in both hips (Table 1).

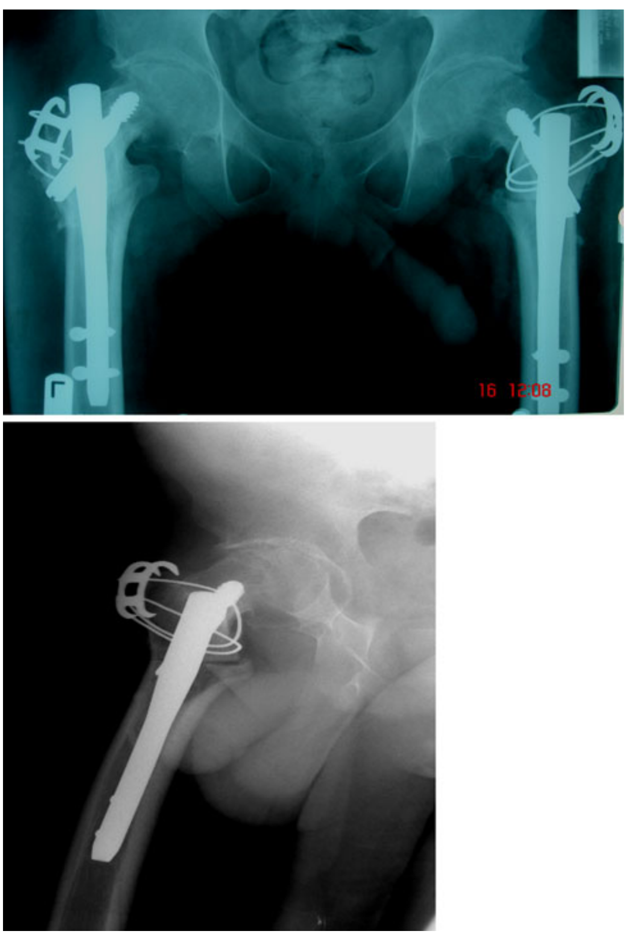

Fig. 4 AP and oblique view of the *right side* after bilateral osteotomy stabilised by short gamma nail

Table 1 Range of movement 5 years post-operatively

Movement	Right side	Left side
Flexion	100	100
Extension	5	10
Abduction	15	30
Adduction	5	10
External rotation (extension)	20	35
Internal rotation (extension)	10	10

Result

At the most recent follow-up, the patient was 21 years old and 5 years post-surgery. Clinical and radiological assessment was carried out (Fig. 5). He had a normal gait, with no limb length discrepancy and satisfactory range of rotation (Fig. 6). He complained of some soreness in his right hip, and on examination his abduction was slightly decreased. This correlated with X-ray finding of some new osteophyte formation superiorly at the head neck junction, which could block hip abduction. His symptoms were not bad enough at the present to justify any surgical intervention. A validated evaluation in the form of IOWA, and Harris Scores were carried out (Table 2).

Radiological assessment showed full healing of osteotomies with satisfactory correction of deformities,

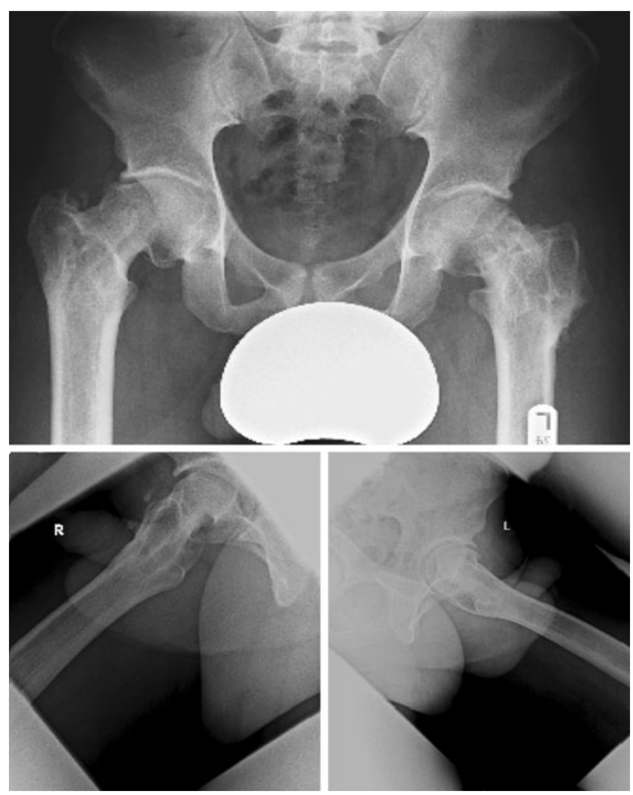

Fig. 5 AP and lateral views of both hips 4 years after osteotomy

Fig. 6 The patient 5 years post-osteotomy, with no limb discrepancy and satisfactory range of rotation

Table 2 Hip scoring on both sides 4 years post-osteotomy

Hip	Harris score	Iowa hip score
Right	81.6	65
Left	81.7	76

(Fig. 5). We noted grade 1 and 2 osteoarthritic changes on the left and right side, respectively, according to Boyer et al.'s [5] criteria. No avascular necrosis (AVN) or chondrolysis was detected on magnetic resonance imaging (MRI) scanning.

Discussion

Extracapsular hip fractures have been historically treated with extramedullary fixation devices, namely Dynamic hip screw (DHS), 90° blade plate and 95° dynamic compression screw. The disadvantage of these devices when used for unstable fractures was that they had a longer lever arm and were placed lateral to the line of load bearing, leading to higher risk of fracture displacement, nonunion and malunion. The advantages of a second generation of cephalomedullary devices are a shorter lever arm and load shearing rather than load bearing; this leads to increased stability and hence it takes greater force to displace a fracture. Gamma nail was designed in 1985 and since then several design changes were made to improve the results. The initial design used in 100 patients had three main complications: fracture of the greater trochanter due to excessive medial curvature of the nail, late coxa vara deformity due to disengagement of the shoulder of the hip screw and external rotation of the femur due to rotation of the rod in the femoral canal. This was improved by reducing the nail curvature, moving the shoulder of the hip screw proximally, and adding different nail lengths and diameters and a distal locking screw. This significantly improved the previous complications; however, the risk of femoral shaft fracture remained [7]. A meta-analysis of initial studies from 1991 onwards showed 4.5 times increased risk of shaft fracture compared to dynamic compression screw; however, more recent studies from 2000 to 2005 showed no significant increased risk of femur shaft fracture. This meta-analysis suggested that shaft fracture risk with Gamma nails had been resolved with improved implant design and improved learning curves with the device [4]. Despite all the advantages and good results, Gamma nail to our knowledge has never been used for stabilising corrective osteotomy in SUFE.

Imhauser three-dimensional intertrochanteric corrective osteotomy was described in 1957 with blade plate stabilisation with or without Kirschner wires fixation of the femoral head epiphysis. Many different hardwares are mentioned in literature, e.g., AO-blade plates and AO-condylar plates [8], but none described the use of a short Gamma locking nail®. A 130° blade plate was used by Parsch et al. [9] as a revision tool in case of blade plate failure with good outcome.

In our patient, the Gamma locking nail® was used for stabilising the tri-plane osteotomy. The stability it provides due to its obvious bio-mechanical advantages reflected positively on the patient rehabilitation, as there was no need for post-operative hip spica, and early mobilisation and range of motion exercises could be commenced day 1 post-surgery.

Our patient had excellent result with tri-planar osteotomy stabilised with Gamma nail®. We feel that there is room for increased awareness in the use of Gamma nail® in such patients.

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Conflict of interest None.

References

1. Abraham E, Garst J, Barmada R (1993) Treatment of moderate to severe slipped capital femoral epiphysis with extracapsular base-of-neck osteotomy. J Pediatr Orthop 13(3):294–302
2. Aronsson DD, Loder RT, Breur GJ et al (2006) Review article. Slipped capital femoral epiphysis: current concepts. J Am Acad Orthop Surg 14(12):666–679
3. Barden B, Loer F, Fitzek JG (1999) Intertrochanteric osteotomy with a short intramedullary locking nail. Int Orthop 23(6):337–340
4. Bhandari M, Schemitsch E, Jonsson A, Zlowodzki M, Haidukewych GJ (2009) Gamma nails revisited: gamma nail versus compression hip screws in the management of intertrochanteric fractures of the hip: a meta-analysis. J Orthop Trauma 23(6):460–464
5. Boyer DW, Mickelson MR, Ponseti IV (1981) Slipped capital femoral epiphysis. Long-term follow-up study of one hundred and twenty-one patients. J Bone Jt Sur Am 63(1):85–95
6. Crawford AH (1988) Slipped capital femoral epiphysis. J Bone Jt Sur Am 70:1422–1427
7. Halder SC (1992) The gamma nail for peritrochanteric fractures. J Bone Jt Sur 74-B:340–344
8. Kartenbender K, Cordier W, Katthagen BD (2000) Long term follow-up study after corrective imhauser osteotomy for severe slipped capital femoral epiphysis. J Paediatr Orthop 20(6):749–756
9. Parsch K, Zehender H, Buhl H et al (1999) Intertrochanteric corrective osteotomy for moderate and severe chronic slipped capital femoral epiphysis. J Paediatr Orthop 8:223–230
10. Southwick WO (1973) Compression fixation after biplane intertrochanteric osteotomy for slipped capital femoral epiphysis: a technical improvement. J Bone Jt Surg Am 55:1218–1224