

Complete Slippage of Capital Femoral Epiphysis: Total Hip Arthroplasty with Custom-Made Stem. Case Study.

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SUMMARY

Slipped capital femoral epiphysis occurs in adolescents, most often shortly after the onset of puberty. In patients suffering from renal osteodystrophy, the incidence is higher and the condition usually occurs at a younger age. Metabolic changes induce weakening of the bone, which makes the hip joint vulnerable. The initial treatment consists of phosphate-restricted diet, lanthanum carbonate, cinacalcet (a calcimimetic), calcium carbonate and oral calcitriol, aiming at restoration of bone quality. The use of several surgical treatment options has been reported.

In this case, which was diagnosed at a later age because no radiographic work-up was performed in the patient's homeland, the only possible treatment option was a total hip arthroplasty. The use of a commercially available femoral stem was impossible because of the abnormal anatomy of the proximal femur. This patient was treated with a custom stem prosthesis manufactured intraoperatively.

Six weeks post surgery, HHS and VAS were improved. Ten weeks post surgery a fracture of the femoral diaphysis was treated with revision surgery using a 20 cm long custom-made stem. At 12 weeks post surgery progressive physical therapy is being instituted.

Timely detection of slipped capital femoral epiphysis is a cornerstone of adequate management. In this specific case, the diagnosis was missed and salvage treatment required total hip arthroplasty with a stem prosthesis adapted to the patient's anatomy.

Key words: slipped capital femoral epiphysis, total hip arthroplasty, custom-made stem prosthesis

BACKGROUND

Slipped capital femoral epiphysis (SCFE) is a disorder characterized by a backward slip of the proximal femoral epiphysis. Idiopathic SCFE occurs in adolescents, most often shortly after the onset of puberty and is attributed to the weakening of the growth plate. The incidence of idiopathic SCFE is about 10 in 100,000 [1,2]

The incidence of SCFE in patients with renal osteodystrophy is much higher, and is caused by deregulation of the calcium and phosphorus homeostasis. Apel et al. reported SCFE in 8 out of 129 patients with chronic renal failure [3]. Up to 90 percent of patients receiving chronic hemodialysis may develop renal osteodystrophy. Due to chronic renal failure, renal phosphate excretion decreases, leading to retention of inorganic phosphate. Hyperphosphatemia is a direct stimulus for the synthesis of parathyroid hormone (PTH), causing secondary hyperparathyroidism. Hyperphosphatemia is also an indirect stimulus by lowering the ionized calcium level and suppression of calcitriol production [4]. If left untreated, both conditions lead to hypomineralization of otherwise normal osteoid, resulting in typical bone changes.

A slipped capital femoral epiphysis in a patient with renal osteodystrophy is more likely to be the result of a stress fracture in the metaphyseal area due to weakening of the bone. The secondary hyperparathyroidism causing osteodystrophy results in metaphyseal weakening, widening of the physis, and coxa vara. In general, patients with renal osteodystrophy tend to develop SCFE at a younger age than patients with idiopathic SCFE.

We report the case of a late diagnosed SCFE in a patient with osteodystrophy ultimately treated with

total hip arthroplasty using a custom femoral stem prosthesis prepared intraoperatively.

CASE HISTORY

A 21-year-old Syrian male (height 154 cm, weight 48.5 kg) reported to our outpatient clinic on account of pain in both hips and limping. His medical history revealed chronic renal failure of unknown origin diagnosed in Syria at the age of 14. Since 2003 the patient has been treated with hemodialysis three times a week. He was treated for chronic hepatitis C with interferon at the age of 17. The patient had experienced increasing pain for four years but radiographs were never performed until he came to our country in 2007. The gait perimeter is reduced to in house only and the patient uses a crutch to walk. At the time of the first consultation the Harris Hip Score (HHS) was: 39.30 and the Visual Analogue Pain Score (VAS) was 9/10. Pharmacological treatment consisting of; phosphate restricted diet, lanthanum carbonate, cinacalcet (a calcimimetic), calcium carbonate; and oral calcitriol (1,25 dihydroxyvitamin D3) was started.

Clinical examination revealed a short stature. A positive Trendelenburg sign and gait pattern was observed. Both hips were painful on mobilization, the right hip being distinctly more so than the left. Further orthopedic examination revealed a dorsal dextroconvex scoliosis, bilateral flatfoot deformity, and bilateral valgus deformity of the knees. Leg length discrepancy of about 2cm in favor of the left leg was observed.

Plain radiographs (Figure 1) demonstrated a severe slip of the left femoral head and a complete slip of the femoral head on the right. A full spine radiograph confirmed a severe dextroconvex thoraco-

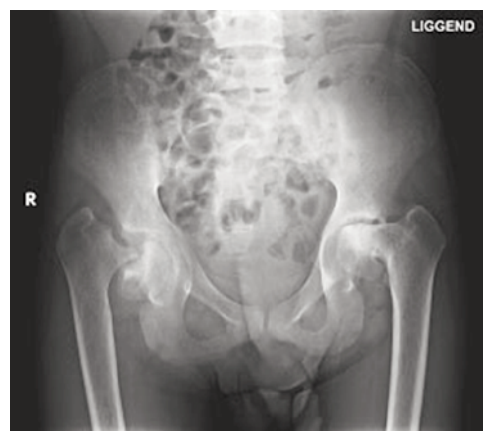


Fig. 1. Plain radiograph of the pelvis: the right hip has slipped completely through the metaphysis, resulting in a cranial displacement of the femur without any remaining contact between the femoral head and neck. The left hip shows a clear varus deformation due to SCFE and flattening of the femoral head

lumbar scoliosis. Computed tomography of the pelvis with three dimensional reconstruction was performed. Figures 2 and 3 show a complete slip of the right femoral head and severe slip of the left femoral head.

TREATMENT

Conservative treatment was instituted for approximately one year, but could not alleviate the symptoms and a total hip arthroplasty of the right hip was performed. Due to the small and abnormal configuration of the proximal femur an intraoperatively manufactured stem prosthesis was used.

The hip was approached with a standard antero-lateral Watson Jones approach. The hip was dislocated and the femoral canal was opened through the piriformic fossa with a sharp broach. A set of reamers was used to open the femoral canal. During reaming, a small fissure of the femoral cortex occurred. To prevent progression, tension band wiring was performed. A thin elastic latex moulding bag was introduced in the femoral canal and filled under pressure

with liquid medical grade silicone. After polymerisation, the silicone mould was removed. The mould was scanned with a laser reader. These numerical data were used to calculate the shape of the femoral stem, aiming for maximal fill of the femoral canal and maximal contact with the metaphyseal femoral cortex. A milling device was instructed to machine the calculated form out of a raw block. A layer of hydroxyapatite HA was applied to the proximal third of the stem using the plasma spray technique. (70-80 μ thick layer; Cam implants, Leiden, the Netherlands). The complete process took fifty-five minutes. During production of the femoral component, the acetabulum was prepared and a Pinnacle acetabular component (DePuy Orthopaedics, Inc., Warsaw, IN) 50 millimetres in diameter was impacted press-fit. Because of the underlying condition two cancellous bone screws were used for further fixation of the cup. A ten-degree lipped polyethylene liner with an inner diameter of 28 mm was impacted. The custom made femoral implant was cemented using 40 grams of Optipac Biomet Bone Cement V, (Biomet, Warsaw, IN). A trial reduction was performed with a trial

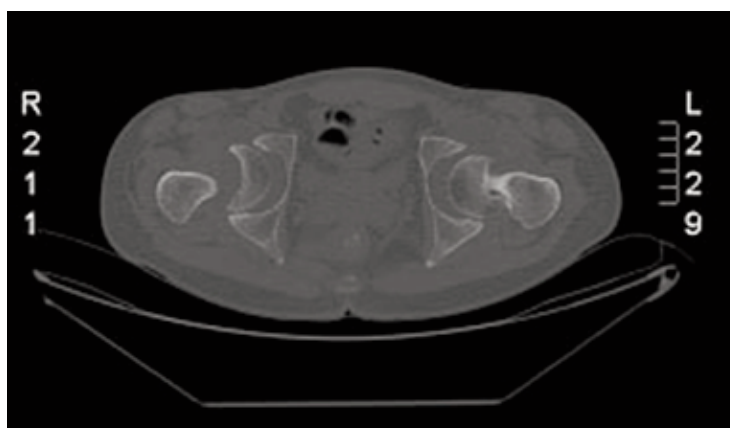


Fig. 2. Total loss of contact between the right femoral head and neck

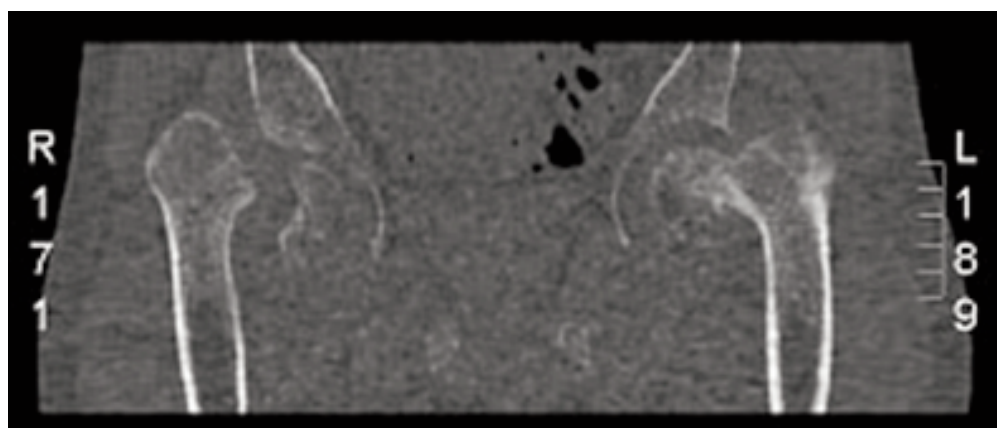


Fig. 3. Loss of contact between the femoral head and neck on the right side and severe slip and varus position of the femoral head on the left side

head. According to the trial results, a final 28-mm cobalt-chrome femoral head (Ultamed, DePuy, Warsaw, IN) was used. The hip was reduced and the wound was closed. No complications were recorded during the hospitalisation. The patient was allowed partial weight-bearing with two crutches.

OUTCOME

The patient was evaluated in our outpatient clinic at 6 weeks postoperatively. The HHS had improved to 68.0 vs 39.3 preoperatively and the VAS pain score was reduced from 9/10 to 3/10. Radiography of the hip showed a well positioned THA without signs of loosening. The screws for fixation of the acetabular component protruded into the acetabulum but did not provoke clinical symptoms (Figure 4).

Ten weeks postoperatively, the patient felt sudden pain and noticed a deformity in his right femur while performing active knee flexion exercises in bed. Radiography revealed a Vancouver B1 type fracture of the femoral diaphysis at the level of the tip of the femoral stem.

A revision surgery was performed. A 20-centimetre-long custom-made stem was used (Figure 5). As the data obtained during primary surgery were used to produce the custom made stem prosthesis, a stem with a longer diaphyseal part could be produced preoperatively. The hip was approached in the same way as during the index surgery but extended distally. The

primary stem and cement were removed. A strut tibial allograft was used to bridge the fractured area and a morcelized allograft was applied to the fracture site. The acetabular component proved to be well fixed and did not need to be revised. The screws were not changed as the cup was well fixed and it was decided that no additional risk for loosening should be taken by attempting to change screw placement. Postoperatively only plantar touch was allowed during the first few weeks.

The patient was evaluated in our outpatient clinic at 12 weeks post revision surgery. The HHS was 78 and VAS 3/10. Radiography of the hip showed a well positioned THA without signs of loosening. The patient was allowed to progressively increase weight bearing and the brace was removed.

DISCUSSION

This case of SCFE was diagnosed late in the course of the disease because no radiographic studies had been performed. The patient had bilateral SCFE. This was also reported by Oppenheim, who reported bilateral involvement in 9 out of 11 consecutive patients diagnosed with SCFE in the course of renal osteodystrophy [5].

When renal osteodystrophy is diagnosed, medical treatment should be initiated to restore calcium and phosphorus homeostasis. The treatment consists in a phosphate-restricted diet and oral phosphate-bind-



Fig. 4. Radiograph of the right hip 6 weeks postoperatively



Fig. 5. Post operative radiograph after treatment of the fracture, 12 weeks after revision surgery

ing agents to lower serum phosphate levels, supplementing calcium intake and the administration of oral calcitriol. Calcitriol suppresses PTH secretion [4]. In our case, medical treatment was initiated one year before surgery and consists in a phosphate-restricted diet and lanthanum carbonate given to reduce phosphorus levels by binding phosphates in the gastrointestinal tract and thus reducing intestinal phosphorus absorption. Cinacalcet (a calcimimetic) is also administered to treat secondary hyperparathyroidism by controlling PTH. The remaining medications are calcium carbonate to increase calcium intake and oral calcitriol (1,25-dihydroxyvitamin D3). This therapy should restore calcium and phosphorus homeostasis. The efficacy of the medical treatment has been monitored by determining serum PTH and alkaline phosphatase levels. Our patient had a PTH level of 115.4 ng/l and an alkaline phosphatase level of 472 U/L; these figures are within the treatment goals for patients with chronic hemodialysis according to the NKF-K/DOQ. Serum calcium was slightly lower and serum phosphorus was slightly higher than the optimal treatment goal. The acceptable PTH serum level reflects good medical control of the secondary hyperparathyroidism and, consequently, increased bone mineral density. This has to be achieved before performing surgery.

If diagnosed in time, in some cases with a low degree of slippage, medicinal treatment of renal osteodystrophy in combination with non-weight-bearing, can prevent further slippage of the physis [5,6]. Restoring the calcium–phosphate homeostasis will optimize mineralization of bone, thus pre-

venting further slippage. It is therefore important that the disease is detected at an early stage. Patients with chronic renal failure under hemodialysis should be followed carefully and questioning about hip or knee symptoms is extremely important in these patients. This should be part of the routine examination. If SCFE is suspected, plain radiography in the standing position and in the frog-leg position should be performed.

For patients with advanced SCFE, surgical intervention to stabilise the slippage of the physis is indicated [6]. Various methods are described in the literature with moderate to good results such as multiple types of pinning, traction reduction and internal fixation, cannulated screws, and osteotomy [5,6,7,8,9,10].

In our patient, however, due to the complete slippage of the femoral head, these surgical treatment options could not be considered. Conservative treatment was continued for one year but this could not alleviate symptoms. A trial period of one year for conservative treatment seems a reasonable period of time to allow bone to regenerate to be of sufficient quality before suggesting a surgical procedure. Because of the severe pain on the right side, a right-sided THA was proposed. Because of bilateral involvement an arthrodesis would not be a surgical alternative. The young age of this patient could be a relative contraindication for hip arthroplasty, although recent reports in literature confirm excellent results in young patients and describe THA as a viable option for younger patients [11]. However, the severity of the symptoms and the failure of conservative treatment for one year justified the need for

further treatment, where in our opinion could a THA was the only option.

The unusual anatomy of the proximal femur justified the use of a custom-made stem prosthesis. The short stature of the patient and morphology of the hip on radiographs were indicative of a small configuration of the proximal femur and this was confirmed after dislocating the hip intraoperatively. In our department custom-made femoral stem prostheses have been used in more than five thousand cases since 1986 [12]. The small and anatomically abnormal femoral canal could not accommodate a commercially available off-the-shelf prosthesis. The intraoperatively manufactured prosthesis (IMP) was cemented because bone quality in this patient was judged to be insufficient to withstand the stresses generated while impacting an uncemented press-fit stem, which became evident when a fissure occurred during reaming. The need for cementing was also justified by the round shape of the proximal femur. This shape of a femoral implant cannot offer enough rotational stability to allow cementless fixation. Tejawani et al. recommend using a cemented femoral implant if the femoral bone stock is judged to be insufficient [13].

The post-operative fracture occurred at a typical location just below the tip of the femoral stem. This fracture in metabolically weakened bone is probably caused by increased stress due to difference in elasticity between the femoral stem and the cortex. The fracture occurred despite medical control of secondary hyperparathyroidism. For revision surgery, a longer stem prosthesis was used, allowing for stabilization of the femur.

CONCLUSION

The incidence of SCFE in young patients with chronic renal failure is higher than in the general population. Early diagnosis may prevent further slipping provided secondary hyperparathyroidism is treated. Therefore it is important to be alert for the potential of SCFE in this patient population. Patients should be regularly questioned about lower limb pain and gait problems and, in case of any doubt, plain and frog-leg radiographs should be taken to exclude SCFE.

In a complete and painful slippage, THA can be a therapeutic option. Care has to be taken to optimize medical treatment so pre-operative bone mineralization is increased to prevent postoperative fractures.

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