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Southwick osteotomy in stable slipped capital femoral epiphysis: A long-term outcome study

Stabil femur başı epifiz kaymasında Southwick osteotomisi: Uzun dönem sonuçlar

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Objectives: Moderate to severe chronic stable slipped capital femoral epiphysis (SCFE) produce permanent irregularities in the femoral head and acetabulum. We report a single centre long-term outcome study of Southwick's procedure for the management of moderate or severe stable chronic SCFE with irregularity of the femoral head.

Methods: In the period from January 1978 to January 1990, 20 patients (16 girls, 4 boys; mean age 13 years; range 11 to 15 years) underwent 22 Southwick osteotomies for chronic stable SCFE with closure or partial closure of the growth plate and a slip between 30° and 70°. All osteotomies were performed by the same surgeon. Patients were followed-up for an average of 22 years (range 16 to 28 years).

Results: External rotation deformity was corrected, and the Trendelenburg sign was hardly observable in any of the patients from six months of surgery. Radiographically, all patients showed full consolidation of the osteotomy within two months of surgery. There was no further epiphyseal slipping. We did not encounter any infection or avascular necrosis. Only one patient developed chondrolysis, which resolved fully in eight months. At the latest follow-up, no limb length discrepancy was seen in 18 patients, while two patients had a mean of 0.8 cm shortening. Eight patients (36.4%) showed radiographic evidence for degenerative joint disease, but none were symptomatic.

Conclusion: The management of chronic stable (moderate to severe) SCFE by Southwick's osteotomy is safe, but technically demanding. It affords good predictable outcome with a low complication rate.

Key words: Epiphyses, slipped/surgery; femur head/surgery; hip joint/surgery; osteotomy/methods.

Amaç: Orta dereceden ileri dereceye kadar olan kronik stabil femur başı epifiz kayması (FBEK) femur başında ve asetabulumda kalıcı bozukluklara neden olur. Bu yazıda, femur başında düzensizliğin de eşlik ettiği, stabil kronik orta veya ileri derecede FBEK için yapılan Southwick işleminin tekmerkezli uzun dönem sonuçları sunuldu.

Çalışma planı: Ocak 1978 - Ocak 1990 tarihleri arasında, büyüme plağı kapalı ya da yarı kapalı, kayma miktarı 30°-70° arasında olan kronik stabil FBEK'li 20 hastaya (16 kız, 4 erkek; ort. yaş 13; dağılım 11-15) 22 Southwick osteotomisi uygulandı. Osteotomilerin hepsi aynı cerrah tarafından yapıldı. Hastaların ortalama takip süresi 22 yıl (dağılım 16-28 yıl) idi.

Sonuçlar: Eksternal rotasyon deformitesi düzeltildi ve Trendelenburg bulgusu ameliyattan altı ay sonra tüm hastalarda neredeyse tamamen kayboldu. Radyografik olarak tüm hastalarda ameliyattan sonraki iki ay içinde osteotomi bölgesinde tam kaynama sağlandı. Hiçbir hastada epifizyel kayma görülmedi. Enfeksiyon ya da avasküler nekroza rastlanmadı. Sadece bir hastada sekiz ay içinde tamamen iyileşen kondroliz görüldü. Son kontrollerde ekstremite uzunluğu 18 hastada eşitti. İki hastada ortalama 0.8 cm kısalık görüldü. Sekiz hastada (%36.4) dejeneratif eklem hastalığına ilişkin radyografik bulgu saptandı, bunlardan hiçbiri semptomatik değildi.

Çıkarımlar: Orta-ileri derecede FBEK'nin Southwick osteotomisi ile tedavisi güvenli, fakat teknik olarak zor bir yöntemdir. Komplikasyon oranı düşüktür ve iyi ve öngörülebilir bir sonuç sağlar.

Anahtar sözcükler: Epifiz, kayma/cerrahi; femur başı/cerrahi; kalça eklemi/cerrahi; osteotomi/yöntem.

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Chronic stable slipped capital femoral epiphysis (SCFE) can be managed either by osteotomies through the neck of the femur[1] or at its base.[2] These procedures carry a relatively high risk for chondrolysis and avascular necrosis.[1,3-5] Comparatively, trochanteric osteotomies seem safer.[6] We report a single centre long-term outcome study of Southwick's intertrochanteric biplane osteotomy for chronic SCFE, with closed or partially closed growth plate and a slip between 30° and 70°.[7]

Patients and methods

Between January 1978 and January 1990, 22 Southwick osteotomies were performed in 20 patients (16 girls, 4 boys; mean age 13 years; range 11 to 15 years). One boy and one girl underwent bilateral osteotomy. Of the 18 unilateral osteotomies, 15 were in the left hips, and three were in the right hips.

Ethics approval was obtained for the study from the local ethics committee. All the patients included in this study gave consent for possible publication of the study results and use of their clinical photographs. Inclusion criteria of the study included chronic SCFE with moderate to severe slip (based on the head-shaft angle method),[7] with either fused or partially closed physis with altered femoral head and neck. The exclusion criteria were acute SCFE, and chronic SCFE of mild severity with a relatively normal femoral head and neck.

SCFE more than three weeks of duration was referred as 'chronic slip'. We graded the severity of SCFE according to the head-shaft angle method.[7] If the head shaft angle was 0°, with physeal widening only, we considered this to be a pre-slip; between 1° and 29° as mild slip; between 30° and 50°, as moderate slip; above 51° as severe slip. We used the degree of slip and its chronicity as the guiding factors in planning the management.

Preoperative planning

Preoperative planning was performed comparing the amount of deformity of the affected side to the uninvolved hip. In two patients with bilateral SCFE, the goal of the operation was to return the physeal-neck angle as close to that of normal. In all patients, we measured limb length, and preoperative and postoperative range of motion of both hips after adequate pain relief to avoid standardization error.

Clinically, we determined the degree of varus angulation by measuring the loss of abduction. The loss of flexion, compared with the normal side, corresponded to the amount of posterior tilting of the slipped femoral head. The angle of the slip was measured on anteroposterior and frog-leg lateral roentgenograms. On the anteroposterior view, the average slip was 21° (range 12° to 30°). On the frog-leg lateral view, the average slip was 61° (range 46° to 80°). Lower limb external rotation deformity was evaluated clinically under anaesthesia. The width of the joint space and the epiphyseal plate were measured directly on anteroposterior roentgenograms.

Operative technique

With the patient supine, both lower limbs were prepped and draped. We used the position of the patella of the normal contralateral limb as a guide to directly compare the rotational deformity of the affected limb. A Watson-Jones approach to the hip was used. Templates already prepared based on the preoperative radiographic measurements were used to perform the Southwick's osteotomy (Fig. 1a-d).

The surgeon introduced the blade-plate guide into the femoral neck 1.5 cm below the greater trochanter, taking into account the valgus and the flexion corrections to be affected. Once the optimal angle and position of introduction to correct the deformity was identified, the blade-plate guide was removed, and a 130° AO blade-plate 5 or 6 cm long was introduced 1.5 cm distal to the greater trochanter (Figure 1e). The osteotomy was then performed. We did not transfix the epiphyseal plate in patients with a partially closed physis. The growth plate will fuse without further slipping once the deformity is corrected.

The tendon of the ileo-psoas was routinely detached from its insertion on the lesser trochanter to prevent tension on the hip produced by the internal rotation of the limb, and to partially limit the valgus effect induced by the osteotomy. Postoperatively, hip flexor strength was not tested routinely, but none of the patients had difficulty in climbing stairs. The plate was inserted until complete contact with the diaphyseal fragment was achieved, abducting and flexing the femur. In this fashion, the femoral head came in the desired valgus and flexion position.

The external rotation deformity of the affected limb was corrected by internal rotation of the femur.

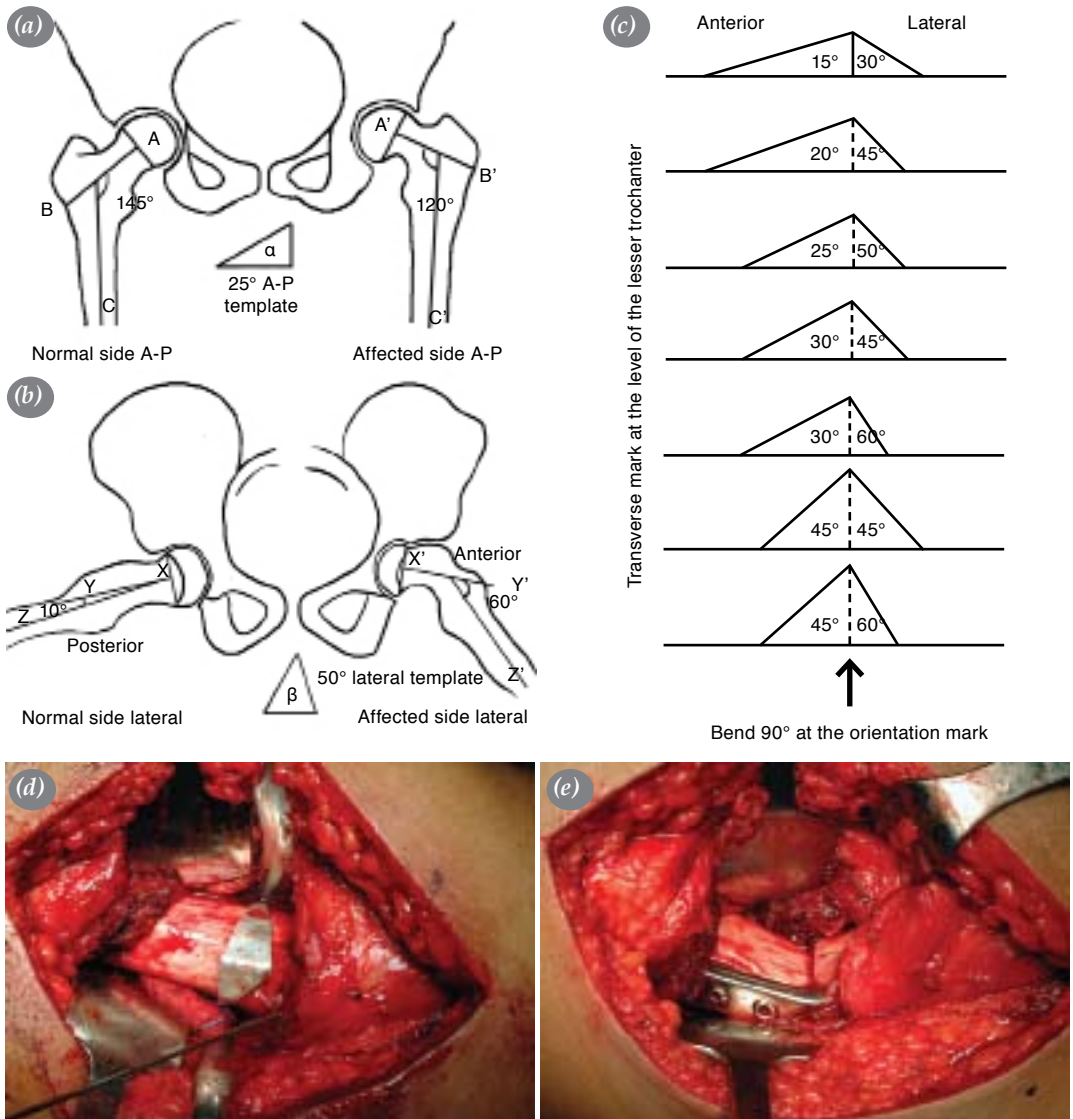

Fig 1. Determination of measurements from plain radiographs for correction of slipped epiphysis.* **(a)** Difference in angle determines anterior osteotomy template {ABC-A'B'C'= α (α is 25º in the above example)}. **(b)** Posterior angulation of affected side minus normal retroversion determines angle of lateral osteotomy template {X'Y'Z'-XYZ=β (β is 50º in the above example)}. **(c)** Template models (actual size) recommended for a patient about five feet six inches tall.* **(d)** Intraoperative view. The template for the wedge of bone to be removed is applied to the femur in the pre-determined position. Image intensification is used for accurate placement. **(e)** The procedure has been completed with blade plate after closing the wedge. The plate is secured to the femur. Note the flexion and abduction at the osteotomy site. *(Redrawn by C Shanmugam from Southwick WO. Osteotomy through the lesser trochanter for slipped capital femoral epiphysis. J Bone Joint Surg Am 1967;49(5): 807-35, with permission from JBJS Am; license number: 1744810359764)

The rest of the corrections obtained by wedge resection were not changed, as one would expect because of the dynamicity involved in correction. The affected limb was rotated internally until the position of the patella fell within 10º of external rotation from neutral. The plate was then secured to the femur in a standard fashion (Fig. 2).

After the procedure, a hip spica cast was applied and kept for four weeks to contain the head concentrically in the socket, and to protect the fixation. After removal of the plaster, physiotherapy was started, first with partial weight-bearing for three weeks, then with weight-bearing slowly increased on the operated leg over the next 6 to 10 weeks. We routinely removed

Fig. 2. 12-year-old boy. **(a)** Measurement of the slip on anteroposterior and frog-leg lateral radiographs. **(b)** Immediate postoperative anteroposterior and lateral radiographs. Note the flexion at the osteotomy site. **(c)** Follow-up at 15 years (age 27). There is some loss of joint space superiorly. The patient is asymptomatic, windsurfs regularly, and plays five-a-side soccer once a week.

the metal work one year after the index procedure unless the child or the parents refused to undergo this further procedure. We recommended partial weight bearing for two months after removal of the implants to prevent fractures.

Patients were evaluated clinically and radiographically on a yearly basis. The mean follow-up period was 22 years (range 16 to 28 years). The primary outcome measures were pain in the hip, epiphyseal slip, and range of motion. The secondary outcome measures were limb length discrepancy, changes of the Southwick radiographic angles, and degenerative joint disease. Complications of chondrolysis, infections, and delayed union of the osteotomized site after surgery were also evaluated.

Results

Clinically, pain and hip deformity in flexion, adduction, and external rotation disappeared in all patients. Similarly, the Trendelenburg sign also disappeared in all patients within six months of surgery. In 18 patients, limb lengths were equal at latest follow-up. Two patients showed an average shortening of 0.8 cm (range 0.5 - 1 cm).

Flexion increased by an average of 26.5° (range 10°-40°), abduction increased by an average of 24° (range 5° - 45°), internal rotation increased by an average of 26° (range 5° - 40°), while adduction decreased by an average of 12.5° (range 5° - 25°). External rotation decreased by an average of 15° (range 5° - 40°) in 14 patients, increased by an average of 10° (range 5°-15°) in seven patients, and remained the same in one patient.

Radiographically, all patients showed full consolidation of the osteotomy within two months of surgery. There was also complete closure of partially fused physeal plate with no further epiphyseal slipping. The valgus angles measured on the anteroposterior radiographs increased by an average of 24° (range 10° - 53°). The angles of retroversion, measured on the frog-leg lateral radiographs showed an average correction of 40° (range 10° - 56°).

Fig. 3. 10-year-old girl. **(a)** The left side had undergone the index procedure nine months before a contralateral SCFE occurred. **(b)** 13 months after the procedure on the right. **(c)** Follow-up at age 27. Antero-posterior radiograph and frog-leg view lateral radiograph. The left hip joint shows the radiographic signs of degenerative joint disease. However, she was asymptomatic.

Only one patient suffered chondrolysis. Fortunately, the patient recovered fully within eight months. No irreversible chondrolysis, infection, or avascular necrosis of the femoral head were encountered. Eight patients (36.4%) showed radiographic evidence for degenerative joint disease (Fig. 3). None of them was symptomatic (5 patients grade 1, 3 patients grade 2).[2]

All patients had a normal active life, and none used non-steroidal anti-inflammatory drugs or analgesics for hip pain. None engaged in competitive sports, but all were able to walk, cycle, and swim when needed. Four played tennis, six jogged, and three played soccer on an occasional basis with no hip pain.

Discussion

The management options of chronic stable SCFE include *in situ* pinning for mild slips, bone peg epiphyseodesis and osteotomy for moderate or severe slips, or a combination of *in situ* pinning and intertrochanteric osteotomy depending on the acuteness and severity of the slip.[8,9] Some authors recommended *in situ* pinning,[10-12] and some bone peg epiphysiodesis[13,14] for moderate slip. Southwick described an intertrochanteric biplane osteotomy for chronic SCFE with closed or partially closed growth plate and a slip between 30° and 70°.[15-19] The restoration of hip function can be expected in almost every patient, if the procedure is performed accurately.[18]

A recent study showed no statistically significant difference at final outcome between an extracapsular osteotomy at the base of the neck and Southwick osteotomy. Both types of osteotomy are equally safe and effective for the management of moderate to severe chronic SCFE, with minimal risks for avascular necrosis and chondrolysis.[20] This study will not clarify the question whether Southwick osteotomy is comparable with the results of *in situ* fixation, because the indications are different from each other. However, no consensus exists about the management of the condition, and several options have been studied in moderate and severe slip.[21]

The blade-plate allowed stable fixation of the osteotomy facilitating complete consolidation within two months from surgery in all patients, and early rehabilitation after plaster removal. The compressive forces came into play, inducing early closure of the

physeal plate, and we did not see any further slipping of the femoral epiphysis, or delayed union at the osteotomy site.[22] We did not use transphyseal devices due to their high risk for complications.[15,23]

There was no reason observed for the reversed sex incidence ratio, which, in our cohort, was the opposite of what has been described as normal. Osteotomies through the neck of the femur[1,5] or at its base[3,4] have a high rate of complications including chondrolysis and avascular necrosis. Comparatively, trochanteric osteotomies seem safer.[6,17,18,24] We never encountered complications such as infections, progressive chondrolysis, and avascular necrosis. Only one patient experienced transient chondrolysis which resolved within eight months from surgery. At an average follow-up of 22 years, only eight patients showed radiographic evidence for degenerative joint disease. Nevertheless, none of them was symptomatic. Therefore, we believe that this technique is effective if the appropriate indications are followed and accurate preoperative planning executed.

Southwick osteotomy may produce flexion deformity of the diaphyseo-ephiphyseal area which may complicate the insertion of a femoral stem, if a conventional total hip replacement is later undertaken.[15,22] All patients in our study group showed excellent bone remodeling of the intertrochanteric area after removal of the blade-plate. Nevertheless, one should be prepared to use custom-made implants for these patients.

A major strength of the present study is that it is a prospective investigation performed at the same institution with all patients being evaluated, enrolled, and operated on by the same surgeon (FC) and with the same technique. Postoperative management was uniform throughout the study, and the operating surgeon was not involved in the final assessment of the patients to eliminate observer bias. We achieved a 100% follow-up rate.

We acknowledge that the evidence given for assessing postsurgical outcomes and for establishing causation is not as strong as that which would be produced by a randomized controlled trial. A randomized controlled trial comparing the management of chronic stable moderate and severe slips with *in situ* fixation and Southwick osteotomy will be clinically more relevant. However, despite this limitation, studies such as this marry the realities of clinical practice with the rigours of scientific investigation, and can be valuable for the formulation of hypotheses for future prospective randomized trials.

In conclusion, Southwick's osteotomy is a safe but technically demanding procedure for the management of chronic stable (moderate to severe) SCFE. It affords a good predictable outcome with a low complication rate.

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