Severe slipped capital femoral epiphysis: The Dunn’s operation

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KEYWORDS
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Summary
Introduction: Severe slipped capital femoral epiphysis inevitably results into arthritis, making surgical recovery of normal anatomy an attractive objective. This can be achieved by the procedure described by Dunn. However, all published studies report a risk of avascular necrosis.

Material and methods: The present series assembles 25 adolescent cases aged 10 to 15 years. There were 16 cases of chronic pure displacement with several months’ evolution, including nine exacerbated by an acute accident. In all cases, epiphyseal slippage was severe, between $60^\circ$ and $90^\circ$. Postoperative traction was systematic, for 15 to 21 days. As of 1979, bone scan was prescribed 2 weeks postsurgery to study femoral head vascularization.

Results: Reduction was anatomic, except in two cases in which the epiphysis was fixed, respectively in caput valgum and in $15^\circ$ varus. There were 15 good results, with clinically and radiologically normal hips, but also 10 immediate or late complications: i.e., a complications rate of 40%. The eight immediate complications (32%) comprised four necroses (16%), two of which rapidly evolved into arthritis, three chondrolyses, which all evolved into arthritis, and one mechanical complication. At less than 10 years’ FU, two arthrodeses and three hip replacements were required. At long-term FU, there were two further late deteriorations, despite initial favorable clinical and X-ray outcomes.

Discussion: In theory, the procedure described by Dunn limits the vascular risk of the displacement correction. It does, however, involve certain tricky technical points: trochanterotomy may be excessive or insufficient; posterior cervical periosteal detachment may be aggressive; and the periosteum may be too tight during the reduction. In all series studying Dunn’s operation, such risk of necrotic complication is reported, at rates up to 17%. The present series had a 16% rate of necrosis which, associated with chondrolysis, caused immediate loss of joint function — unacceptable, in our view, in adolescent patients. A direct approach to the displacement, after arthrotomy, with associated anterior cuneiform neck resection, corrects the slippage while avoiding the risky first two steps of Dunn’s procedure, and is our current approach of choice.

Level of evidence: Level IV, retrospective therapeutic study.

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Introduction

Chronic severe slipped capital femoral epiphysis considerably alters hip joint architecture, inexorably leading to arthritis [3]. Restoring normal anatomy is an attractive prospect, made difficult, however, by the risk of an iatrogenic damage to epiphyseal vascularization. In 1964, Dunn [1] designed a procedure taking account of this vascular issue while enabling anatomic reduction of the epiphyseal displacement. In 1990, we reported a series of 14 Dunn’s procedures at 8 years’ follow-up, with encouraging results inasmuch as there was no femoral head necrosis [2]. Today, with 25 cases, our conclusions are less cut and dried, in view of the large number of early and late complications.

Material and methods

Twenty-five Dunn’s operations were performed between 1974 and 2003, on children aged between 10 and 15 years. Sixteen cases were of pure progressive displacement with several months’ evolution, and nine involved a further instability-related accident. All the slipped capital femoral epiphyses showed X-ray alterations characteristic of progressive displacement: metaphyseal deformity with anterior bony hump and posterior pseudo-osteophyte aspect, clearly visible on lateral view.

The tilt, calculated from the true femoral neck profile, was consistently large, ranging from 60° to 90° (mean = 80°).

As analyzed on X-ray or in some cases on bone-scan images, no growth plates were in epiphysiodesis.

All but two of the operations were performed by the same surgeon, ensuring a certain homogeneity in the series. After extra-digital trochanterotomy, subperiosteal detachment was achieved by disinserting first the vastus lateralis muscle, then the entire trochanteric region; after anterosuperior capsulotomy, detachment continued right around the neck of the femur. The epiphysis was then detached from the neck by a spatula gently introduced into the physis, so as to remain in contact with the vessel-bearing periosteal lamina. The metaphyseal region, and the postero-inferior beak in particular, was then regularized. This completely separated the epiphysis and metaphysis. The reduction was maintained by backward and forward pinning previously implemented in the neck of the femur, with a compression screw when the diameter was sufficient. Postoperative traction was systematically maintained for between 15 and 21 days. As of 1979, bone scan was prescribed 2 weeks postsurgery, to study femoral head vascularization.

Results

Reduction was anatomic, except in two cases in which the epiphysis was fixed respectively in caput valgum and 15° varus.

There were 15 good results, with mobility identical to that on the non-operated side, no pain and normal X-ray aspect at FU of 15 years in three cases, 10 years in three, 4 years in four and 3 years in five.

There were, however, 10 immediate or late complications, amounting to 40% of cases.

The eight immediate complications (32%) included four necroses (16%: two total and two superior polar) diagnosed on postoperative bone scan. Arthritis evolved within 2 to 4 years, and only the two partial necroses were still well tolerated at 6 and 7 years’ FU, respectively. At 3 years, the two total necroses were treated in one case by arthrodesis and in the other by hip replacement. Necrosis developed despite the displacement being pure and chronic: i.e., free of any instability.

Although this is not a problem specific to the present technique, it is to be noted that three chondrolyses (12%) developed in the immediate postoperative course. Joint stiffening and pinching persisted despite the continuation of traction, developing into disabling arthritis after 1, 4 and 10 years, respectively, requiring hip replacement at 4 years and arthrodesis at 10 years postoperatively in the two patients so far operated. None on these chondrolyses were accompanied by abnormalities on bone scan.

There was one mechanical complication (4%) at 6 months’ FU, in a context of partial weakening of the trochanter neck by screw revision to manage greater trochanter nonunion. A simple fall, following revision, fractured the base of the trochanter neck, with nascent arthritis appearing 18 months later. Total hip replacement was performed 11 years after the Dunn’s operation.

Over long-term follow-up, there were also two late deteriorations (8%) despite initially favorable clinical, X-ray and bone-scan findings. One 14 year-old boy showed superior polar deformity of the femoral head at 3 years’ FU, which evolved into clinical and radiographic arthritis requiring hip replacement at 10 years. The displacement was stable, at 80° (Figs. 1a and 1b). The reduction obtained with the Dunn’s operation was anatomic (Figs. 2a and 2b), with symmetric epiphyseal scintigraphic perfusion. Just before ablation of the osteosynthesis material at 10 months, the femoral head was spherical (Figs. 3a and 3b). The hip became painful by month 3, with nascent arthritis on X-ray (Figs. 4a and 4b).

The other case of deterioration was a girl operated on at the age of 13, who experienced mechanical pain in the hip at 10 years postoperatively.

At end of follow-up, 40% of the hips were problematic, including the 24% with immediate problems (two total necroses, three chondrolyses and one fracture) which have to be considered serious as they affected adolescents who quickly and definitively lost joint function.

Figure 1  (a) and (b) 14 years, gonalgia for 7 months, stable slipped capital femoral epiphysis with 80° displacement.
Discussion

In slipped capital femoral epiphysis, any possible metaphyseal remodeling will be insufficient if the displacement exceeds $40^\circ$, as areas without cartilage will be exposed, unavoidably leading to arthritis after 25 years [3]. In case of severe displacement, anatomic reconstruction of the superior extremity of the femur thus seems to be a logical attitude; such intervention, however, should not accelerate the natural evolution towards arthritis. The main risk of surgery is that epiphyseal vascularization will be impaired by periosteal retraction. In theory, Dunn’s procedure [1] limits this risk; but the operation involves certain difficulties.

Firstly, the trochanterotomy should go beyond the trochanteric fossa, after location of the gluteal and vastus lateralis crest insertion. It has to be neither too great, so as to avoid damaging the medial circumflex artery branches composing the extracapsular vascular ring [4,5], and not too small, otherwise the trochanteric fossa will be detached blindly, incurring the same vascular risks. Ideally, it should stop beyond the trochanteric fossa.

The second difficulty is to detach the epiphysis from the metaphysis by spatula, without threatening the periosteal insertion.

And finally, it is hard, during reduction, to assess without greatly shortening the periosteal sleeve behind the neck.

All reports of Dunn’s operation find such risk of necrosis, to degrees varying from 12 to 17% (see Table 1) [6—13]. The present series had a 16% necrosis rate. Rostoucher et al. [14] reported similar findings in 1996.

Given that the correction is to be made where the deformity is — i.e., at the growth plate — how is vascular risk to be limited?

An anterior approach, following anterior arthrotomy and with painstaking detachment of the anterior neck periosteum, simultaneously and progressively associating anterior cuneiform resection in the metaphyseal region, can correct tilt but not slippage. The vascular risk is reduced. The high-risk period of trochanterotomy is effectively avoided, and periosteal detachment is less extensive. Fish [15], in 1984, reported a series of 48 hips with just one case of necrosis. The vascular risk is not entirely abolished, however: De Rosa et al. [16] reported four cases out of 27 operated hips, as well as coxitis.

Late secondary deterioration despite anatomic femoral extremity reconstruction is not unknown in the literature. Carlioz et al. [8] reported a 15% rate of suspicious X-ray aspects suggestive of minimal necrosis. Szypryt et al. [10] reported a 20% rate of arthritis, aside from all immediate complications, and Broughton et al. [11] found only 11 normal hips out of 23 followed up for more than 20 years. Such late deterioration despite anatomic initial reduction suggests minimal ischemia overlooked on bone scan, or reduced joint cartilage resistance accounting for secondary loss of mobility. Unfortunately, no technique would seem to circumvent this risk.

Conclusions

Dunn’s very attractive procedure always manages to reduce the anatomic disturbance caused by epiphyseal slippage and tilt. Our experience, however, is that as the number of cases increases so does the number of immediate complications. These complications almost systematically lead to rapid and painful loss of hip function in young adolescents. This seems unacceptable to us, being finally more prejudicial than the natural evolution of the pathology. Reduction by anterior
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osteotomy therefore seems to us, as to others, to pose less vascular risk, and is our current attitude.

References