Original article

Modified Dunn osteotomy using an anterior approach used to treat 26 cases of SCFE

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A B S T R A C T

Introduction: Osteotomy performed below the femoral neck plays a leading role in the treatment of slipped capital femoral epiphysis (SCFE). It results in anatomical reduction. Several modifications have been made to Dunn’s original osteotomy technique. We have developed another modification to this technique that uses an anterior surgical approach on a traction table with fluoroscopy control.

Hypotheses: Will this technique help to reduce the number of complications? Will its results be superior to those achieved with the standard Dunn osteotomy procedure?

Material and methods: This was a retrospective single-center study of 26 cases in 24 patients (2 bilateral cases). Patients were positioned supine on a traction table with fluoroscopy control. An anterior surgical approach was used. A trapezoid-shaped osteotomy was performed below the femoral head. The head’s reduction was checked on the fluoroscope and the fixation confirmed. The Postel Merle d’Aubigné (PMA) score was used for the clinical assessment. The radiographic assessment was based on Southwick’s angle.

Results: The mean slip angle of the femoral head was 57°. A mean correction of 47° was achieved. Based on the PMA score, good and excellent results were achieved in 20 cases (77%) and poor results occurred in 6 cases (23%). The surgical treatment had a significant effect on the PMA score (P=0.0008). In terms of complications, there were five cases of chondrolysis and one case of necrosis associated with chondrolysis.

Discussion: The anterior approach provides direct access to the femoral neck, and thereby a cautious osteotomy at the site of the slip itself. Use of a traction table makes the external manipulations, reduction and fixation procedures easier to carry out. The results of this study were comparable to published results.

Level of proof: IV, retrospective treatment study.

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1. Introduction

The treatment of proximal slipped capital femoral epiphysis (SCFE) has long been controversial [1–4]. Various surgical techniques have been described, from in situ fixation to osteotomy of the proximal femur, or even epiphysiodesis and anterior neck osteoplasty [3,5–10]. Among these techniques, methods that incorporate an osteotomy play a leading role. An osteotomy directly or indirectly restores the slipped epiphysis. The osteotomy can be performed as different levels: subcapital [11,12], at the base of the neck [13,14], between the trochanters and under the trochanters [15,16]. The advantage of the subcapital osteotomy described by Dunn [11] is that it corrects the deformity at the femoral head’s growth plate. The primary risk associated with this osteotomy is damaging the posterior branch of the medial femoral circumflex artery (MFCA) during the approach and reduction [17–20]. In his original article, Dunn used a lateral approach with a trochanterotomy [11]. A trapezoid-shaped osteotomy was performed below the femoral head to shorten the femoral neck by a few millimeters posteriorly; this released the posterior capsule and posterior branch of the MFCA. It also achieved a more anatomical correction of the deformity [11,12]. However, the risk of avascular necrosis (AVN) due to damage of the posterior MCFA branch during the approach and/or osteotomy has led to the development of variations in the osteotomy level and the approaches used [3,8,21]. Monin et al. [22] showed that hip osteoarthritis occurred in every patient with more than 40° slip. They recommended surgical repositioning in cases of severe SCFE.

We carried out a study in which Dunn’s osteotomy was performed through an anterior approach using a traction table and fluoroscopic check of the screw fixation. We wanted to answer the following questions: is this new technique reproducible? Will it
help to reduce the number of complications? Will its results be superior to those achieved with the standard Dunn osteotomy procedure?

2. Materials and methods

This was a continuous, retrospective single-center study of cases performed between 2005 and 2011. Included were children with stable SCFE graded as Southwick type II or III [15]. Excluded were patients with an unstable SCFE, stable type I SCFE or those with established radiological necrosis. The study comprised 24 patients (21 boys, 3 girls), with two patients having bilateral SCFE. The average patient age was 16 years (range: 13–18). The average body mass index was 20 (range: 16–23). The symptoms had been present for an average of 10 months (4–28 months) before the surgical treatment. The SCFE was classified as Southwick type III in 14 cases and type II in 12 cases. The mean slip angle of the femoral head was 57° (40–80°). The average preoperative PMA score was 12 (10–15).

The surgical procedure was performed with the patient supine on a traction table with use of fluoroscopy (Fig. 1). A Hueter anterior approach was used. The capsule was opened using a crossbow incision. With the leg externally rotated, a 1.6-mm K-wire was placed in the femoral head at the end of the hyaline cartilage (Fig. 2). It was used as a joystick to reposition the head on the femoral neck after the osteotomy had been carried out. A trapezoid-shaped osteotomy was performed with curved chisel. The posterior portion was completed carefully using bone nibblers. Reduction of the head was confirmed on anteroposterior and lateral fluoroscopic views. Fluoroscopy was also used to guide the placement of a 1.8-mm stabilizing K-wire and a 1.6-mm guide wire (Fig. 3a). The position of the K-wires was then verified on lateral views (Fig. 3b). The screw tract was drilled (Fig. 4). A 6.5-mm diameter cannulated cancellous bone screw with short terminal threads and a washer was inserted percutaneously. The stabilizing K-wire was left in place by bending its tip over and burying it. The capsule was closed with two suture throws. The average procedure time was 90 minutes (60–120 min).

In the postoperative phase, no weight-bearing was allowed during the first 3 months; partial weight-bearing was allowed during the next 3 months.

Patients were evaluated after a mean follow-up 5 years (3–8 years). The outcomes were evaluated clinically using the Postel Merle d’Aubigné (PMA) score [23]. The radiographic assessment was based on Southwick’s angle. Any mechanical complications, AVN of the femoral head or chondrolysis were recorded. Statistical analysis was performed using Spearman, Fisher and Wilcoxon tests and a P-value of 0.05.

3. Results

Study results are given in Table 1. A mean correction of 47° was achieved after surgery (10–70). The mean postoperative PMA was 16 (11–18). Based on the PMA score, good and excellent results were achieved in 20 cases (77%) and poor results occurred in 6 cases (23%). Fig. 5 shows the radiographic outcome of a female patient with a bilateral SCFE treated by Dunn’s osteotomy. The surgical treatment significantly improved the PMA score (P=0.0008).

There were three cases of chondrolysis among the type II cases (one associated with AVN) and three cases among the type III cases.
The patient who suffered AVN with chondrolysis had a preoperative slip angle of 45°, was treated 12 months after symptoms appeared and had a preoperative PMA score of 10. There was no statistical relationship between the appearances of AVN or chondrolysis and the preoperative PMA score or slip angle. Fig. 6 shows the radiographic outcome of a male patient treated with a Dunn osteotomy who suffered chondrolysis.

4. Discussion

The goal of treating SCFE is to prevent premature hip osteoarthritis due to femoroacetabular impingement with anterior cam effect [24, 25]. This prearthritic deformity can be prevented by restoring the anatomical relationships between the femoral head and acetabulum as closely as possible. Many surgical techniques

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Outcomes by type of SCFE.</th>
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</thead>
<tbody>
<tr>
<td>Southwick classification</td>
<td>Type II (n = 12)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>16.16</td>
</tr>
<tr>
<td>BMI</td>
<td>20.58</td>
</tr>
<tr>
<td>Symptom duration (months)</td>
<td>11.33</td>
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<tr>
<td>Preoperative PMA score</td>
<td>11.66</td>
</tr>
<tr>
<td>Postoperative PMA score</td>
<td>16.33</td>
</tr>
<tr>
<td>Initial slip angle of femoral head (degrees)</td>
<td>48.33</td>
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<tr>
<td>Correction achieved (degrees)</td>
<td>43.75</td>
</tr>
<tr>
<td>Follow-up (months)</td>
<td>12.91</td>
</tr>
<tr>
<td>Chondrolysis</td>
<td>2</td>
</tr>
<tr>
<td>Necrosis + chondrolysis</td>
<td>1</td>
</tr>
</tbody>
</table>

There was no statistically significant difference between the groups with a good postoperative PMA score and a poor one (P = 0.15). Similarly, there was no statistically significant differences in terms of age (P = 0.77), preoperative slip angle (P = 0.59), and duration of symptoms (P = 0.15) on the degree of improvement in the postoperative PMA score.
have been proposed to restore the hip joint’s anatomy. They can be separated into intra- and extracapsular techniques according to the osteotomy level and the approach used [26–29]. Although the former are better able to correct the deformity because they are closer to the site, they are known to damage to the posterior branch of the MCFA, with AVN as a consequence [7,12,20,30–36]. The correction can be carried out at the site of the deformity itself using a Dunn osteotomy, with extra care being taken during the approach to spare the posterior branch of the MCFA [17]. However, positioning patients on their side makes it difficult to use fluoroscopy; reduction of the greater trochanter is also prone to complications [37,38]. Ziebarth et al. [39] proposed a modification of the Dunn technique where a transstrochanteric approach was used with the patient lying on the side and the hip surgically dislocated. Although the results of this procedure were satisfactory, we find it to be too invasive.

The duration of symptoms negatively affects the outcome of the surgical treatment. Ziebarth et al. [39] observed cartilage damage intraoperatively that was significantly correlated with the duration of symptoms. The fact that the duration of symptoms is associated with cartilage damage calls into question whether osteoarthritis can be prevented in the years following the epiphyseal slip, despite anatomical reconstruction. We found no significant effect of the duration of symptoms on the improvement in the PMA score. However, we believe that a longer duration of symptoms equates to a lower preoperative PMA score.

Published results of epiphysis reduction after SCFE reveal a relatively high rate of osteonecrosis among different studies (10% to 100%) [18,19,40–44]. Ziebarth et al. [39] found no signs of AVN in their 40 patients treated with Dunn technique and surgical dislocation, but noted that preoperative cartilage damage was present in 25 of 26 patients with stable SCFE and 3 of 10 patients with unstable SCFE. Slongo et al. [3] found 91% excellent results and 9% poor results due to chondrolysis and AVN in a group of 23 patients treated with a modified Dunn osteotomy. This AVN rate was lower than the 7% rate reported by Madan et al. [45] in 28 patients operated using the Ganz technique. In our study, we found five cases of chondrolysis (19%) and one case of AVN associated with chondrolysis (4%).

The majority of published studies include obese patients with the gynoid pattern of obesity [46,47]. In our study, the predominant body type was a tall and slender Sahelian one, with an average BMI of 20 (range: 16–23). This made the surgical approach easier in our patients and reduced the procedure duration.

The contribution of the traction table to our results cannot be ignored. It allows for rotation and traction maneuvers, making it easier to expose the femoral head and thereby to perform the osteotomy. Use of fluoroscopy also ensures that the femoral head is reduced correctly. It also guides the placement of the stabilizing K-wire and the fixation screw, while making sure the joint cartilage on the femoral head is not breached, which can cause chondrolysis.

Our goal was to determine the reliability of an osteotomy below the femoral head as described by Dunn, but through a less damaging anterior approach. This study showed the possibility of performing a Dunn osteotomy without having to dislocate the femoral head, with a lower rate of vascular complications. Our satisfactory results are comparable to published results in terms of the incidence of AVN (4%) and chondrolysis (21%). As shown by various authors, the latter complication is due to pre-existing labral and cartilage damage because an anterior cam effect [3,39,48]. We recommend early diagnosis and early treatment before these prearthritic lesions develop. This technique has its place in the treatment arsenal for moderate and severe cases of SCFE.

However, as in other cohort studies, the primary weakness is the lack of a control group to compare our results with. Nevertheless, the study consisted of a homogenous group of patients who were operated using the same surgical technique at a single center.

5. Conclusion

All new techniques used to treat moderate and severe SCFE have satisfactory results in the short term. Use of the anterior surgical approach and a traction table were an important contributor to our satisfactory results, which are comparable to published results. The surgical approach is a standard one. The below-the-neck osteotomy technique requires substantial experience in pediatric hip surgery. Good knowledge of the hip’s anatomy gives the surgeon better control over the procedures. We hope that restoring the anatomical relationship between the femoral head and acetabulum will mean that the results are maintained over time.

Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.otsr.2015.10.005.

References

Slipped physis.


