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The value of preliminary overhead traction in the closed management of DDH

Received: 12 November 2005 / Revised: 11 December 2005 / Accepted: 3 January 2006 / Published online: 7 March 2006
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Abstract We aimed to discover whether there is a difference in incidence of growth disturbances of the proximal femoral epiphysis and final results in two similar groups of children with developmental dislocation of the hip (DDH) treated with (107 hips) and without (48 hips) overhead traction. The only variable between the groups was the use of preliminary traction. All children were followed up until at least the age of 14 years. Pre-reduction traction should be used among children treated non-operatively for DDH who are older than one year of age and/or have high-dislocated hips. In cases that are diagnosed late, this treatment would reduce the risk of severe growth disturbances and increase the probability of a favourable long-term outcome.

Résumé Le but de cette étude est de déterminer s'il existe un trouble de croissance de l'extrémité supérieure du fémur, en fin de croissance sur deux groupes d'enfants, présentant une luxation congénitale de hanche traitée avec ou sans traction préliminaire (107 hanches avec traction, 48 hanches sans traction). La seule variable de ces groupes a été l'utilisation de la traction préliminaire. Tous les enfants ont été suivis jusqu'à l'âge de 14 ans. Les enfants traités par une traction préliminaire ont été surtout ceux traités orthopédiquement avec une luxation relativement haute, ces enfants étaient en moyenne âgés d'un an de plus que les autres. Chez les enfants dont le diagnostic a été tardif, le traitement par traction diminue le risque de trouble de la croissance améliorant le résultat à long terme dans la luxation congénitale de la hanche.

Introduction

Advocates for the use of pre-reduction traction maintain that it gently stretches the soft tissues around the hip and reduces the forces between the femoral head and acetabulum. This may decrease the incidence and severity of growth disturbances of the proximal femoral epiphysis [1, 3, 8, 14, 22], facilitate closed reduction, and decrease the need for open reductions [6, 7]. Other authors have suggested that traction has little to add to the management of developmental dislocation of the hip (DDH) [2, 10–12, 15]. The question of how subsequent hip development may depend on the use of traction remains largely unanswered.

The aim of this study was to determine whether there is a difference in the incidence of proximal femoral epiphyseal growth disturbances and final outcomes between two groups of children with DDH treated non-operatively. The only difference between these groups was the use of preliminary traction.

Materials and methods

Between 1962 and 1988, 546 children were treated for DDH using closed reduction. We excluded patients treated operatively, those with neuromuscular disease, those with arthrogryposis, and those who were lost to follow-up.

Our exclusion process left 117 children (155 hips) divided into two groups. The first group consisted of 81 patients (107 hips) treated conservatively with preliminary traction and closed reduction. There were 36 patients in the second group treated without traction.

Beginning in 1967 the use of traction was gradually introduced in our unit for treating children with late DDH, and since 1970 it has become a standard method. However, the other stages of management have not been changed significantly. In the hospital, bilateral traction was begun with the hips flexed at 90–100°, abducted approximately 20° and with the knee joints extended. Adhesive straps were applied to the medial and lateral aspects of the lower extremities from the level of the greater trochanter to the

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ankles. Crepe bandages were applied over the adhesive straps. The traction weight was sufficient to lift both buttocks slightly off the bed. After 5–7 days, the abduction was gradually increased to an angle of about 50°. The hips were examined every second day. When the femoral head was palpable at the level of the acetabulum, the reduction was performed. The average time for traction was 17 days (range 10–40 days).

Closed reduction was performed under general anesthesia. The hip was judged to be adequately reduced when the femoral head felt stable in the acetabulum. The hips were immobilized in a modified Lorenz position [24] (with flexion of more than 100° but avoiding abduction of more than 70°). Concentric reduction was verified with radiographs. After three months the cast was removed under general anaesthesia, and hip stability was assessed. A Lange cast [13] was applied at that stage for the next two months, with another radiograph confirming the presence of the femoral head within the acetabulum. Abduction braces were used as post-reduction for 46 children. None of our children had an adductor tenotomy performed.

Anteroposterior radiographs were obtained at the beginning of treatment and at subsequent clinical visits. According to our follow-up program, for the first year after treatment radiographs are done every three months, and following this every six months or yearly depending on hip development. The radiographs were reviewed to identify growth disturbance of the proximal femoral epiphysis according to the criteria of Bucholz and Ogden [4]. Average age at the last follow-up was 20.7 years (range 14–40 years).

Initial femoral head displacement was evaluated using the Tönnis classification system [21] and the centering ratios of Smith et al. [20]. Parameters used to assess acetabular development and head–acetabulum relationships included the acetabular index of Hilgenreiner [9]; the acetabular angle of Sharp [19]; acetabular depth, width, and quotient [5]; acetabular roof angle [21]; the center-edge angle of Wiberg [23]; the articulo-trochanteric distance; and percentage of femoral head coverage. Femoral head sphericity was evaluated according to the criteria of Mose et al. [16]. Growth disturbances of the proximal femoral epiphysis were evaluated according to the criteria of Bucholz and Ogden [4] and final radiological results according to Severin's classification system [18].

Statistical significance was determined using the χ^2 test, Student's *t*-test, and Fisher's exact test (Statistica for Windows 5.1). The *p*-value for the level of significance was 0.05.

Results

On radiographs taken prior to reduction, the mean acetabular index of Hilgenreiner was 36° (range 22–57°), the mean c/b ratio was 0.98 (range 0.7–1.25), and the mean h/b ratio was 0.04 (range –0.32–0.4). The average age of children was 14.9 months (range 6–32 months). Seven of them were boys. Neither group of patients differed in terms

of age, side, bilateral involvement, post-reduction treatment with abduction braces, acetabular index of Hilgenreiner, femoral displacement measured by the Tönnis classification system, or superior and lateral centering ratio of Smith, as measured on initial radiographs (Table 1).

At the last follow-up, radiographs were reviewed according to our previously stated criteria (Table 2). Statistical differences in radiological results between hips treated with and without traction are presented in Table 3.

Cases that had been classified as grades III and IV according to the Tönnis system were further analysed. Physeal arrest of the proximal femur was identified in 17/29 hips (58.6%) within the group treated without traction and in 21/63 (33.3%) in the first group. This difference was statistically significant ($p < 0.05$). In hips with a grade II dislocation, growth disturbance of the proximal femur was found in 10/44 cases managed with preliminary traction and in 3/19 without it. This showed no statistical difference ($p > 0.05$).

In children older than one year (97 hips), the risk of growth disturbances of the proximal femoral epiphysis was significantly reduced in the traction group ($p < 0.05$; Fig. 1). In children one year of age and younger, physeal arrest was found in 13/41 treated with traction and in 4/17 without it, which was not statistically significant ($p > 0.05$).

Seven out of 20 hips with proximal femoral growth arrest treated without traction and two of 31 hips treated with traction developed type III necrosis according to the Bucholz and Ogden classification system. This difference was statistically significant ($p = 0.037$).

Table 1 Association between parameters before reduction and use of preliminary traction

	Traction (–)	Traction (+)	<i>p</i> -value
Age	16.2 months	14.2 months	>0.05
Side			
Left	29	58	>0.05
Right	19	49	
Bilateral	12	26	
Unilateral	24	55	>0.05
Acetabular index of Hilgenreiner	35.0°	36.5°	>0.05
Superior (h/b) centering ratio of Smith	0.035	0.045	>0.05
Lateral (c/b) centering ratio of Smith	0.98	0.98	>0.05
Level of dislocation			
II°	19	44	
III°	21	48	>0.05
IV°	8	15	
Braces			
No	31	78	>0.05
Yes ^a	17	29	

^aOrtolani brace, Gronier brace, or Denis-Brown brace

Table 2 Radiographic findings for 155 hips at last follow-up

	Range	Mean
Center-edge angle of Wiberg	(-20)–42°	25.4°
Acetabular angle of Sharp	27–66°	43.3°
Acetabular roof angle	0–65°	10.8°
Femoral head coverage	10–100%	81.9%
Acetabular depth	8–28 mm	19.4 mm
Acetabular width	51–103 mm	68.8 mm
Acetabular quotient	0.05–0.46	0.3
Articulotrochanteric distance	0–45 mm	26 mm
Femoral head spherical index ^a	0–12 mm	3.5 mm

^aApplies only to hips with growth disturbances of the proximal femoral epiphysis

Discussion

In this study we analysed the value of overhead traction by comparing two clinically similar groups. The only difference in treatment was whether preliminary traction was used before closed reduction. The follow-up period was long enough to identify all growth disturbances of the capital femoral epiphysis [4, 11].

The use of preliminary traction for managing DDH still has many advocates. In the opinion of Gregosiewicz and Wośko [8], performing closed reduction without traction significantly increases the risk of avascular necrosis of the femoral head. On the basis of a multicenter study, Bednarczyk and Szulc [1] found traction to be very effective. DeRosa and Feller [7] studied 85 cases in which closed reduction was performed after radiographically proven effectiveness of traction; reduction was successful in 91% of cases, and avascular necrosis was not noted in

Table 3 Association between final radiological parameters and use of traction at final follow-up

	Traction (-)	Traction (+)	p-value
Center-edge angle of Wiberg	25.6°	25.3°	>0.05
Acetabular angle of Sharp	43.4°	44.3°	>0.05
Acetabular roof angle	13.1°	9.8°	>0.05
Femoral head coverage	80.7%	82.4%	>0.05
Acetabular depth	19.8 mm	19.3 mm	>0.05
Acetabular width	71.3 mm	67.4 mm	<0.05
Acetabular quotient	0.28	0.31	>0.05
Articulotrochanteric distance	23.4 mm	27.2 mm	<0.01
Femoral head spherical index ^a	4.6 mm	1.96 mm	<0.05
Final radiographic results			
Severin class I and II	40 (83.3%)	86 (80.4%)	>0.05
Severin class III–V	8 (16.7%)	21 (19.6%)	
Growth disturbances of proximal femoral epiphysis			
No	28	76	>0.05
Yes	20 (42%)	31 (29%)	

^aApplies only to hips with growth disturbances of proximal femoral epiphysis

Fig. 1 Avascular necrosis in children age 1 year and older depending on use of preliminary traction

any patient. Langenskiöld and Paavilainen [14] reported a significant reduction in the incidence of avascular necrosis in a group of children treated with preliminary traction; the minimal follow-up period in their study was 13 years, and preliminary traction was the only variable between the two groups.

Statistical analysis within our study showed that premature physcal closure of the proximal femur was significantly reduced by overhead traction in high-dislocated hips (Tönnis grades III and IV) and among children older than one year of age. Its use also has a protective effect against the development of severe types of growth disturbances of the capital femoral epiphysis.

Kahle et al. [10] suggested that preliminary traction neither decreased the prevalence of avascular necrosis nor facilitated closed reduction. However, type I growth disturbances of the capital femoral epiphysis was not maintained to be “real necrosis”; 43% required open reduction, and the follow-up period was relatively short [10]. Only studies that include follow-up to skeletal maturity can report the true incidence of growth disturbances of the proximal femur [4, 11]. Kutlu et al. [12] found that three of 52 patients treated with prereduction traction and none of 40 patients treated without preliminary traction developed avascular necrosis, but the difference was not statistically significant. Children in their studies were much younger compared with our group (mean ages eight and 14.9 months, respectively), and the period of traction was also shorter (means of nine and 16.6 days, respectively) [12]. Brougham et al. [2] analysed a group of children similar to ours. Forty-seven percent had some evidence of avascular necrosis, and the incidence was not influenced by the use of traction. However, their results were not subdivided to give either the rate per age or the rate relative to the degree of dislocation. They also failed to detail an exact treatment program [2]. Segal et al. [17] found no significant difference in the occurrence of avascular necrosis with respect to preliminary traction in children younger than one year, which is in accordance with our results. Some other publications disprove the effectiveness of traction [11, 15]. Comparing these series is very difficult because they differ with regard to many variables, including age of patients, type of traction, follow-up period, and the criteria for defining avascular necrosis or the treatment program.

Whether traction influences final outcome is another question. Our study shows that very good results were found more often than good results in the population treated with traction compared with the non-traction group. Hips treated by closed reduction without traction had a significantly shorter articulo-trochanteric distance and widening of the acetabulum.

The success of achieving closed reduction is yet another subject of debate. DeRosa and Feller [7] reported 91% successful closed reductions after the use of traction. Daoud and Saighi-Bououina [6] found that preliminary traction facilitated closed reduction in children 18–72 months old. On the other hand, Kahle et al. [10] showed no effect of the use of traction on the need for open reduction.

In conclusion, we believe that pre-reduction traction should be used among children treated non-operatively for DDH who are older than one year of age and/or have high-dislocated hips. In those cases that are diagnosed late, this treatment reduces the risk of severe growth disturbances and increases the probability of a favourable long-term outcome.

Acknowledgement Funding for this project was supported by an internal grant from the Medical University of Lodz, Poland (502–11–261).

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