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CONTAINMENT OF THE FEMORAL HEAD IN LEGG-CALVÉ-PERTHES' DISEASE AND ITS PROGNOSTIC SIGNIFICANCE

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The treatment of LCPD employs to an increasing degree the containment principle, in the form of femoral osteotomy, based on the hypothesis that the factor decisive for the prognosis is centralization of the femoral head, and not relief of weight-bearing by the hip.

A follow-up of 48 unilateral LCPD hips treated by strict bed-rest showed a poor correlation (best value $r = -0.385$) between the degree of lateralization of the femoral head (the migration percentage) during the course of the disease and the spherical quotient at follow-up 12.6 years after the onset of the disease.

The results reported, such as shortening of the fragmentation phase and a not unequivocally good outcome of intertrochanteric femoral osteotomy in hips "at risk", may therefore not be due to the containment principle, but perhaps to an improved venous drainage from the femoral head.

Key words: Legg-Calvé-Perthes' disease; Perthes' disease; containment principle; femoral osteotomy

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Salter & Bell (1968) have shown in experimental avascular necrosis in young pigs that the most important factor in the prevention of deformity of the femoral head is centralization of the femoral head with complete coverage by the acetabulum.

Based on the hypothesis that the most important factor in the treatment of Legg-Calvé-Perthes' disease (LCPD) is protection of the growing femoral head against compression by the acetabular margin (Axer 1965, Axer et al. 1973, Larsen & Reimann 1973, Lloyd-Roberts et al. 1976, Somerville 1971), the containment principle is used with increasing frequency. As a consequence of this principle, normal weight-bearing is permitted, once the period of pain is over, provided the femoral head is completely covered by the acetabulum. If there is persistent contracture in the hip adductors, an adductor tenomyotomy is performed to prevent outward migration. If in spite of this the femoral head protrudes outside the acetabulum, a varus derotation femoral osteotomy or an innominate osteotomy is performed (Axer 1965, Canale et al. 1972, Salter et al. 1977, Zweymüller & Wicke 1973). When as a result of this procedure the femoral head becomes completely covered by the acetabulum, full weight-bearing is permitted.

As yet no clinical evaluations are available of the results achieved following this principle, but the results following varus derotation

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femoral osteotomy alone, with an observation period of up to 6 years, suggest that the fragmentation period is reduced (Axer et al. 1973, Puranen & Heikkinen 1976), and that the result is better in the "at risk" group (Catterall 1971) than in untreated patients or in children who have received treatment by means of weight-relieving braces alone (Canale et al. 1972, Laurent 1973, Lloyd-Roberts et al. 1976).

Two different series of children with LCPD were compared by Brotherton & McKibbin (1977) with a control series of untreated children reported by Catterall (1972). One of the two series received treatment with bed-rest with abducted legs, while the other series was the osteotomy material of Lloyd-Roberts et al. (1976). Brotherton & McKibbin found that in Catterall's Group 3, where only a very small portion of the head is not involved, the bed-rest series gave only marginally better results than the osteotomy series, but in Group 4, with total involvement of the femoral head, the benefit obtained in the bed-rest series was considerably better than that obtained in the osteotomy series. They also concluded that the benefits of bed-rest in wide abduction could not be ascribed wholly to the application of the containment principle, and it seemed certain that weight relief played some part, at least when the degree of head involvement was total.

Varus derotation femoral osteotomy is a relatively simple intervention, which should be taken into consideration if the final result is the same as that after treatment by bed-rest or wheelchair (Lauritzen 1975), so that the children can be spared years of inactivity, possibly away from home.

The aim of the present study was therefore to examine the hypothesis of the containment principle in LCPD. For the hypothesis to be confirmed, there should be a good correlation between the degree of lateralization of the femoral head during the course of the disease, and the maintenance of the sphericity of the head several years later.

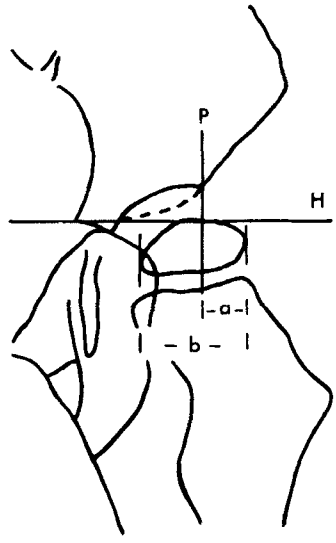

Figure 1. Migration Percentage (MP). P corresponds to Perkins' line, perpendicular to the horizontal line H, and passing through the acetabular edge. MP is then a/b × 100 per cent.

PATIENTS

The material is consecutive and comprises all the LCPD children treated at the Seaside Hospital at Refsnæs from 1952 to 1957 with strict bed-rest followed by Snyder's sling. Excluded from the original material are children with bilateral LCPD, children with complicating bone diseases or under other treatment, and those for whom the radiographs were not available.

The material then consists of 48 children with a median age of 6.2 years (range 2.10–9.11 years) at the onset of the disease. The onset had to be estimated from the anamnesis.

They were treated with bed-rest for a median period of 1.7 years (range 1.1–2.1 years) up to 2 years after the onset (range 1.6–2.11 years).

Method of assessment

Lateralization of the femoral head. The lateralization of the femoral head in relation to the acetabulum is evaluated by measurements on the anteroposterior radiographs to give the Migration Percentage (MP) (Figure 1).

The MP indicates how much of the femoral head extends beyond Perkins' line, in proportion

to the width of the entire head, the measurements being made with the hips in neutral abduction-adduction.

To determine whether the MP can be used to indicate the prognosis, the MP was measured on radiographs which were taken at selected intervals from the presumed onset of the disease.

Roundness of the femoral head. As this investigation includes mature individuals, the often employed Epiphyseal Quotients are not suitable for this purpose, and Mose's rule does not give an exact objective measurement.

The Spherical Percentage (SphP) (Fredensborg 1976) expresses the roundness of the femoral head, given as the percentage of the height of the head in relation to the maximum width of the head. The height is measured at right angles to the width (Figure 2).

The Spherical Quotient (SphQ) indicates the ratio between the SphP of the diseased hip and the SphP of the noninvolved, contralateral femoral head.

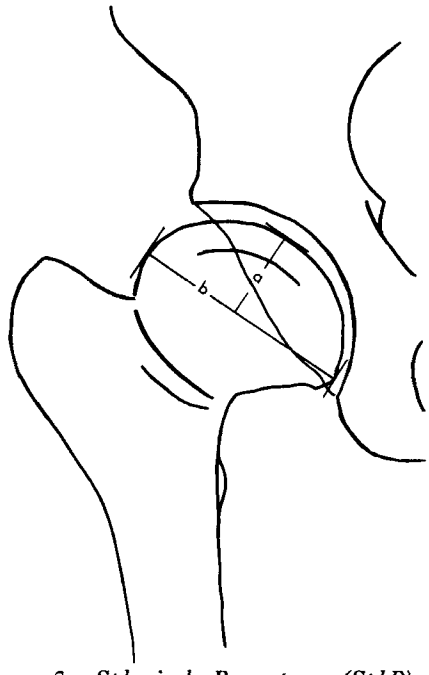

Figure 2. Spherical Percentage (SphP) and Quotient (SphQ). (b) indicates the maximum width and (a) corresponds to the maximum height of the femoral head measured at right angles to (b). SphP is then a/b × 100 per cent. SphQ indicates the SphP of the diseased hip divided by the SphP of the noninvolved, contralateral femoral head × 100 per cent.

RESULTS

The data obtained are given in Table 1. The relationship between the MP values at various intervals after the onset of the disease and the corresponding SphQ values at follow-up are shown. At the half-year and 1 year

Table 1. Data and results obtained at follow-up of 48 children with unilateral LCPD treated with strict bed-rest followed by Snyder's sling. Age of onset was a median of 6.2 years

n	X-rays		Time from onset (years)	Migration Percentage (MP) (per cent)	Spherical Quotient (SphQ) (per cent)	Correlation coefficient *r*, between MP and follow-up SphQ	
48	primary	median range	0.5 0.1–1.6	12 0–34			
38	half-year	median range	0.7 0.5–0.8	13 0–34		0.063	$P > 0.1$
40	one-year	median range	1 0.10–1.2	17 0–39		0.052	$P > 0.1$
48	maximum MP	median range	1.8 0.7–4.1	26 5–48		−0.184	$P > 0.1$
48	end of treatment	median range	2.5 1.2–4.1	22 5–43		−0.385	$P < 0.01$
48	follow-up	median range	12.6 5.11–25.2		92 74–135		

examinations, only those hips were included for which a satisfactory radiograph was available around that time. The only significant correlation found between the SphQ value at follow-up and the MP value was with the MP value at the end of treatment, $r = -0.385$, with $P < 0.01$.

DISCUSSION

The main aim of the present study was to examine whether there is a relationship between the MP during the course of the disease, and the SphQ at follow-up several years later. The investigation shows that there is no significant relationship between the MP values $\frac{1}{2}$ year and 1 year after onset of the disease and the SphQ at follow-up, nor is there any relationship between the maximum lateralization of the femoral head and the SphQ at follow-up. On the other hand, a slight but significant relationship exists between the MP at the end of treatment, a median period of 2.5 years after onset of the disease, and the SphQ at follow-up, a median period of 10 years later.

In the same way, Snyder (1975) found no correlation between the percentage subluxation and the functional outcome of patients studied over an average period of 10.9 years.

These findings signify that the hypothesis of a containment principle in LCPD is probably in error. They also signify that the relationship between the femoral head and the acetabulum, expressed as the MP $\frac{1}{2}$ year and 1 year after onset of the disease, cannot be used as a prognosis, nor can it be taken on its own as an indication for operative reposition of the head.

Suramo et al. (1974), by intraosseous venography, found obstruction in the venous flow in the initial and fragmentation stages of LCPD. Puranen & Heikkinen (1976) found that an osteotomy, performed in the initial stages, improves venous circulation and accelerates the process of healing even to such an extent that the fragmentation stage possibly does not occur at all. The results of the present investigation therefore cannot exclude the possibility that a femoral osteotomy may nevertheless exert a favourable effect, even though the effect is not due to improved containment of the head by the acetabulum.

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