

"Postural Management" to prevent hip dislocation in children with cerebral palsy

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ABSTRACT: Background. Muscolo-skeletal disorders and hip deformity play a key role on future development of motor and adaptive functions in children with cerebral palsy (CP). Lateral migration of the femoral head increases on average 7.7% per year and may progress in association with-acetabular dysplasia to hip dislocation. Conservative preservation of muscle length and balance may prevent or reduce femoral head migration and acetabular dysplasia.
Equipment for position lying, sitting, and standing is an established method of maintaining muscle length and joint range. French approach (Le Métayer et al) include the use of customised plaster cast orthoses, for sitting and standing positions, called siège moulé and gouttière, tailor-made according to the child's muscolo-skeletal characteristics and motor abilities.
At our department, hips with clinical and radiological evidence of displacement unresponsive to pharmacological and surgical treatment were treated with postural management. The two cases we show in this paper underwent a physiotherapy programme (neurodevelopment treatment) twice a week and a seated postural programme 5 hours a day with the siège moulé. Hip radiographs were measured with the migration percentage (MP) described by Reimers.
The follow-up measurements showed a progressive reduction of MP values of the hip treated, confirming the significant benefit from the combined non surgical approach.
The study supports the evidence that conservative management of hip deformity with siège moulé can be successful if implemented before the development of hip dysplasia.

KEY WORDS:Cerebral palsy, Postural management, Hip dislocation, Paediatric deformity

INTRODUCTION

Hip subluxation and dislocation are common features in CP. It has been estimated that 0.68 per 1000 children have significant hip subluxation due to CP by the age of 5 years (1).

Untreated hip subluxation in CP may progress to acetabular dysplasia and hip dislocation. Pelvic obliquity difficulties in sitting may also develop, complicating hygiene and pain management.

Although hip dislocation is most common in non-walking spastic quadriplegics (2), it also occurs in diplegics, usually at a later age (3). A paediatric index for developmental hip problems is delayed locomotor milestones in both type of CP. Scrutton (4) found that

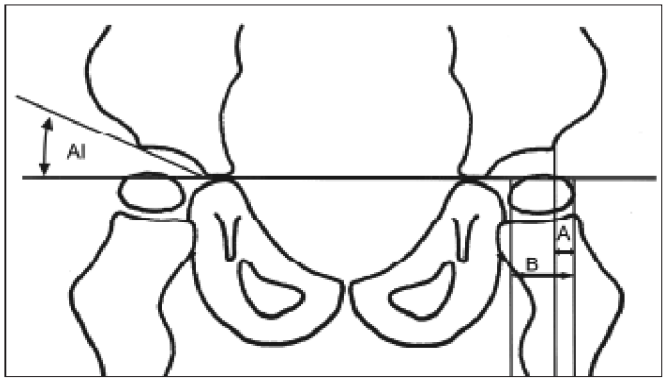


Fig. 1- Reimers' index MP% = A/B.

inability to rise to a standing position by the age of 3 years is highly correlated with hip subluxation. Soft tissue dynamic imbalance between the stronger flexor and adductor muscles, and the weaker extensors and abductors, results in myostatic contractures with growth. Lack of weight bearing then leads to development of progressive structural changes and does not allow physiological development of the acetabolar cavity and proximal femur, resulting in mal-alignment of overall hip joint components (5).

Criteria for the intervention should be defined according to the child's clinical and functional status, pain levels, sleep assessment, percentage of hip migration and long-term prognosis (6). Measuring the percentage of hip migration with an antero-posterior radiograph is the most reliable method of determining the degree of hip subluxation to follow it up.

Several authors believe that an integrated approach to prevent hip problems should include postural management and a physiotherapy programme, botulinum toxin injection, orthoses and surgery.

In a recent study Pountney (7) suggested that if migration percentage (MP) is greater than 15% at 30 months, positioning equipment to control posture is recommended.

Soft tissue surgery can be effective when migration is between 30% and 50% (8), although several studies report that after soft tissue surgery further surgery is needed in over 60% of cases (9).

The recent consensus statement concerning postural management for CP children formulated by a Mac Keith Multidisciplinary Meeting in 2006 (10), proposed early intervention including special seating, night-time support, standing support, active exercise, orthotics, surgical intervention, and individual therapy session, to facilitate communication, cognitive and functional skills, to increase children's comfort and reduce deformity.

Le Métayer proposed different personalised orthoses for seating and standing, and a appropriate physical therapy programme as a prevention method. The *siège moulé* is a custom made seat developed from child body shape with the aim of providing hip abduction, to avoid muscle shortening and asymmetrical positions of the pelvis.

In the last few years we tested the effectiveness of *siège moulé*, in controlling hip subluxation, preventing contracture progression, improving trunk and head control, manipulation and delaying surgery.

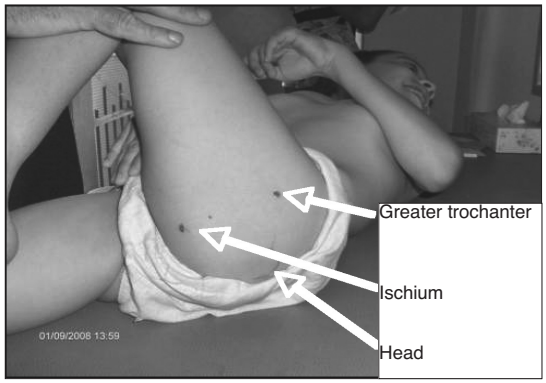
METHODOLOGY

In our department patients with clinical and radiological evidence of hip subluxation, unresponsive to pharmacological and surgical treatment, underwent postural management after Institutional Review Board (IRB)/Ethics Committee approval was obtained. The patients received a physiotherapy programme (neurodevelopment treatment) twice a week and a seated postural programme 5 hours a day with the *siège moulé*. AP pelvic radiographs were measured with the migration percentage (MP) described by Reimers (11) and the data recorded during the patients follow-up. Radiographs were taken in standard position with femurs parallel and patella at zenith, as the measure of MP is influenced by abduction/adduction of the femur and by the pelvic position, both by pelvic lordosis or kyphosis and by rotation about a vertical axis (12).

Hips were considered subluxed with a MP over 33%, migrated and dislocated at over 80% migrated (13) (Fig 1).

Postural management

Rehabilitation programmes focused attention on preventive hip dislocation methods in CP children. The association between phisiotherapy (PT) treatment and equipment to position lying, sitting, and standing is an established method in European countries to prevent the tertiary deformities. In particular the French approach (Le Métayer et al) include the use of customised plaster cast orthoses, for standing and sitting positions, called *siège*



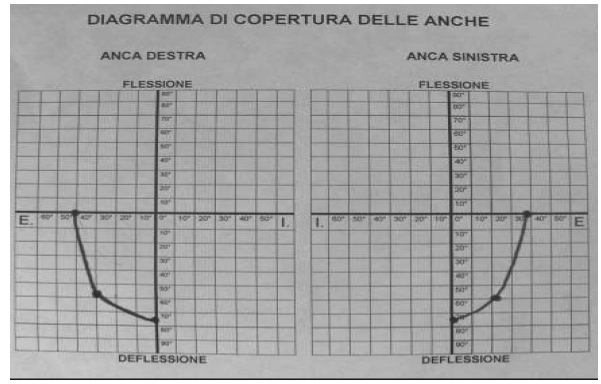
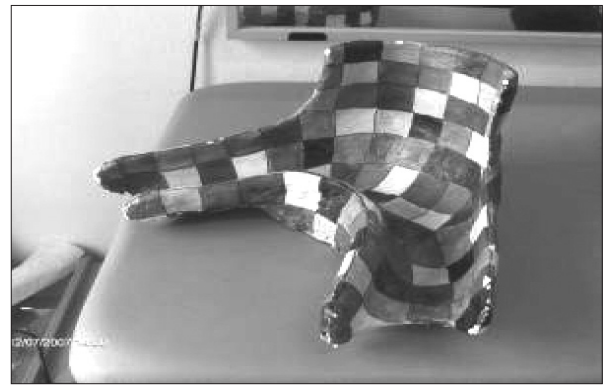


Fig. 2- Hip cover palpation and diagram.



Figs. 3 - Plaster cast.

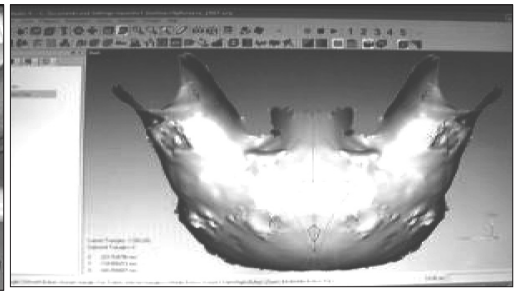
moulé and *gouttière*. These are tailor-made according to the child's postural abilities, range of joint-motion, muscle length and potential neuro-sensorial disorders.

According to Le Métayer (14, 15) the clinical evaluation includes 6 steps:

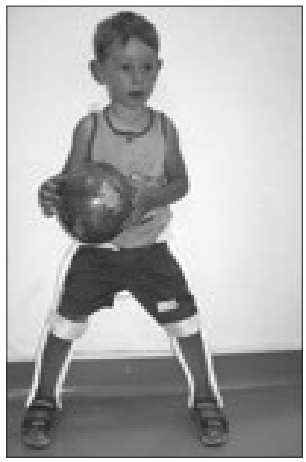
1. Examination of child's neuro-motory skills, proposed by Tardieu (16) and modified by Le Métayer. This scale (0-4) measures the postural and motor function, showing the deficits and the potential abilities related to the child's age. The score 0 suggest a normal answer (function) and 4 a severe impairment with function not possible. MP of the hip radiograms measurements.
2. MP of the radiograms of hip measurements.
3. FA (angle of femoral antiversion) clinical measurements by greater trochanter maximal prominence palpation.
4. Recording hip muscle length measurements (adductor brevis and longus, hip flexors, knee flexors) after relaxing manipulations to distinguish tightness from retraction.
5. Hip concentric reduction determined by hip diagram (HD) by Lespargot (17, 18). The hip cover diagram is built by clinical examination of the hip in different positions and degrees of its in full (ROM) to obtain the safe standing and sitting position protecting the femoral head from subluxation/dislocation. The diagram acertains the degree of lower limb abduction and flexion/extension sufficient for the *siège moulé* to safely contain the hip (Fig. 2).
6. Perceptual sensibility evaluation of the back and lower limbs, with and without visual control, determines the child's level of consciousness related to his body position, or parts of it, in space.

Setting up siège moulé

The child is placed in a prone position, after measurement of the femoral head concentric reduction is



Figs. 4 - Posture *Acquisition data* *Model by cad-cam*



Figs. 5 - Scissor pattern *inhibition function of gouttière*

Fig. 6a - 2-year-old child after toxin.

calculated to obtain better control of trunk-pelvi-femur position. We may make a plaster cast (Fig. 3) or a plastic *siège* with computer model imaging reconstruction (CAD-CAM system), (Fig. 4). This system allows better reproduction of the child's shape compared to other systems (vacuum bag, laser pointer or alteration of the plaster cast in plastic). Use of *siège moulé* for 5 hours/day or more, during upper extremity activities, is combined with a global rehabilitation programme, that needs to be acceptable to the child and the family and easily integrated into their lifestyles.

Fig. 6b - X- Ray before siège: MP right 36%, Cobb 25°. *Fig. 6c - X- Ray after 2 years siège: MP bilateral 20%.*

Setting up gouttière

The same materials and the same procedure are used for the spica splint used for standing position, with or without support for the trunk. Starting from hip flexed at 90° we look for the reduction hip position with the Lespargot diagram. Daily use of *gouttière* allows balance reaction exercises, strengthens trunk muscles and maintains the pelvis and lower limbs in a correct and safe position (Fig 5).

Fig. 7a - 2,5–years-old, MP right 0%, left 20%.

Fig. 7b - 5–years-old dislocated hips, MP right 65%, left 20%.

Fig. 7c - 6–years-old after adduc-tors tenotomy, MP right 55%, left 20%.

Fig. 7d - 8–years-old after 1 year of postural management, MP right 37%, left 25%.

Fig. 7e - 10–years-old: after 3 year of postural system, MP right 16%, left 15%.

CLINICAL EXAMPLES

First case

A 2-year-old female with diagnosis of ataxic diplegia complicated with hydrocephalus.

Level 3 at Tardieu scale: she walks with devices. Pronounced asymmetry of pelvis, right femur head dislocated, right MP 36%, scoliotic curvature and Cobb angle 25°, treated with botulinum toxin injection on adductors bilaterally, without significant results on MP% (Fig. 6a). At 2 and half years old beginning *siège moulé* treatment and In Full (NDT).

At 5 years old after siege for 5 hours per day the pelvis is symmetric, and MP is 20% bilaterally, hips are symmetrical and there is no scoliosis (Figs. 6b, 6c).

Second case

Child with severe impairment, level 4 of Tardieu scale, unable to walk, completely dependent for daily activities. At 5 years of age dislocation of hip, followed by bilateral tenotomy, without results in hip subluxation at 6 years of age. At 7 years of age he started the postural management. We show the X ray at 8 and 10 years, after 1 and 3 years of postural management (*siège* and *gouttière*) (Figs. 7a, b, c, d, e).

DISCUSSION

Hip disorders are common in patients with CP and cover a wide clinical spectrum. Although the hip is normal at birth, and up to the age of approximately 18 months (19), a combination of muscle imbalance and bony deformities leads to progressive subluxation. When morphological degeneration occurs, dislocation and dysplasia are frequently associated with discomfort and pain by early adulthood.

Early detection of hips at risk of progressive subluxation, through clinical and radiological screening, and commencing early conservative treatment with abduction splinting is the main protective goal of hip survey in CP.

We do agree with Scrutton's and Baird's

recommendations to have a hip surveillance X ray programme for all children with CP unable to walk 10 steps at 30 months. If hip adduction is pronounced, a radiograph at 18 months may be helpful. Repeating x-ray control is recommended every 6-12 months until hip migration is stable.

Of the possible risk factors for displacement, Terje Terjesen in a recent paper showed that gait function ability and age were the significant influencing variables. It seems that not only the capacity to walk, but also the degree of gait function is important since the MP progression tended to be less in the diplegics who walked independently than in those who needed support. Fifty-two% of children with quadriplegic CP vs 21% with diplegia required treatment for hip problems by the age of 5 years. Equipment to position lying, sitting, and standing is an established method of maintaining muscle length and joint range. A retrospective review of long-term outcomes of 24h postural approaches by Pountney (20) same as 7 showed that children given the treatment before hip subluxation occurred were significantly more likely to have neither hip subluxed than children who received the treatment after subluxation or not at all.

According to the postural management of CP children consensus statement of 2006 and Pountney's (21) and Hankinson's (22) studies we believe that the introduction of a programme of postural management that maintains muscle length and provides correct joint compression, would interrupt the mechanism of hip dislocation and prevent it.

The *siège moulé* is a custom made seat, developed from the child's body shape. The purposes of this treatment are to:
- maintain alignment of the pelvis and lower extremities, giving a comfortable seated position
- support potential head and trunk weakness, allowing free manipulation of the child
- maintain concentric reduction of the femoral head in the acetabular cavity through the correct degree of thigh abduction calculate with Lespargot plot
- help the social integration of children with CP

Postural management is essential to help direct movement patterns towards ensuring maintenance of muscle length and joint range.

According to the French experience and the recent postural management consensus statement of 2006 attention should be focused on the preventive role of conservative treatment to control hip dysplasia and improve motor, postural, perceptive and manipulation functions. In our experience clinical results are very encouraging. Further prospectives, studied with a wider number of patients (diplegic and tetraplegic) and longer follow-up are needed.

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