e4p Evidence for Practice

Surveillance and Management of Hip Displacement and Dislocation in Children with Neuromotor Disorders Including Cerebral Palsy

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Introduction

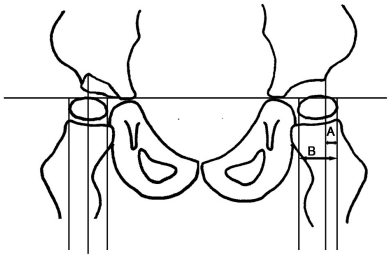
This document contains a brief overview of information regarding hip displacement and dislocation in children with cerebral palsy (CP) and similar conditions, i.e., conditions in which motor impairment is a result of an acquired brain injury early in life. It is intended to provide clinicians with relevant background information on the topic of hip displacement and dislocation.

How was the literature review completed?

An electronic search was performed in May 2011 of the following databases: CDSR, CINAHL, DARE, Embase, MEDLINE, and PEDro. Keywords used in the search included: 'cerebral palsy', 'hip dislocation', hip subluxation', 'hip displacement', and 'hip surveillance' (see Table 1.) The Oxford Centre for Evidence-based Medicine Levels of Evidence were assigned to relevant studies by two reviewers with consensus scores reported throughout the document (see Table 2).[1]

What is hip displacement and dislocation?

Hip displacement refers to the gradual, lateral displacement of the femoral head from under the acetabulum, and is defined by a ***migration percentage*** *(MP). MP* is calculated by dividing the width of the femoral head outside the lateral margin of the acetabulum (A) by the total width of the head of the femur (B).[2] (See Figure 1.)



Slightly different definitions of ***hip displacement*** and ***dislocation*** have been suggested. According to the Consensus Statement on Hip Surveillance for Children with Cerebral Palsy: Australian Standards of Care (2008), ***hip subluxation*** is defined by a MP between 10% and 99%, and can be used interchangeably with the term ***hip displacement***.[3] ***Hip dislocation*** refers to the state of the hip when the femoral head is completely laterally displaced from under the acetabulum (MP=100%).[3] Others have reported slightly different definitions including a migration percentage of 33% to 80% indicating hip subluxation[4,5] and a MP of greater than 80% indicating hip dislocation.[4]

Figure 1. Migration Percentage
(http://www.biomedcentral.com/content/figures/1471-2474-8-101-1-l.jpg)

Who is at risk for developing hip displacement or dislocation and how often does it occur?

In children with CP, reported rates of hip displacement have varied between 2% and 75%.[6] Recent studies have indicated the rate of hip displacement (>30-33% MP) to be around 27 to 35% [7-9] and directly related to Gross Motor Function Classification System (GMFCS)[10] level with a higher level of incidence in children who have greater neurological involvement (GMFCS I = 0% versus GMFCS V = 90%) (evidence level 1b).[9] In children who are ambulatory, 3 to 7% will develop hip displacement.[11] Hip dislocation is, however, preventable with early identification and intervention.[3]

Why do hip displacement and dislocation occur?

In children with conditions such as CP, the hip is normal at birth. However, without the development of typical motor skills, hip dysplasia can occur. The two main causes of hip displacement and dislocation are lack of weight bearing and asymmetry.[12]

Lack of Weight Bearing

Most children are born with a significant amount of femoral anteversion, which decreases with age through loading of the bones. Without typical loading conditions, as with many children with CP, femoral anteversion may actually increase with time and lead to changes in the acetabulum and femur.[12] In children with CP, the degree of femoral anteversion is correlated with GMFCS level; a progressive increase in femoral anteversion has been demonstrated from GMFCS I to III with a plateau in femoral anteversion values from GMFCS III to V.[13] In addition, children with CP have been shown to have increased femoral neck shaft angle values when compared with typical children; femoral neck shaft angle increases from GMFCS I to V.[13]

Asymmetry

Asymmetries in activity of the muscles surrounding the hip are due to spasticity and/or muscular imbalances.[12] Soft tissue abnormalities may include an imbalance between the strong hip flexors and adductors versus the weaker hip extensors and abductors.[12] This can lead to adductor contractures which can affect growth and lead to changes in the acetabulum and femur.[12]

How does hip displacement and dislocation affect individuals?

The consequences of progressive hip displacement are variable and can result in asymmetrical pressures, which can deform the femoral head and/or acetabulum (hip or acetabular dysplasia). These can lead to changes in the 'Body Structures and Functions' components of the *International Classification of Functioning, Disability, and Health (ICF)*[14] which in turn can interfere with the 'Activity & Participation' components of the *ICF.*[2]

Body Structures & Functions

- Degeneration of articular cartilage
- Pain
- Limited range of movement

Activity & Participation

- Function
- Ability to be positioned
- Hygiene and personal care

Progressive hip displacement can progress to hip dislocation.[3] Studies have suggested that a rate of migration of 7% or greater per year could be correlated with a future inability to walk.[15] A MP of 15% at 30 months of age carries a risk of 50% dislocation whereas hips with a MP of 60% or more are considered unstable and require immediate attention.[16] Research suggests that preventative intervention is indicated before the achievement of a MP of 60%.[17]

How can hip dislocation be prevented?

Hip dislocation is preventable through surveillance and early identification followed by appropriate intervention; studies indicate a significant decrease in the incidence of hip dislocation after the implementation of a prevention program (evidence levels 2c and 4).[17,18]

Surveillance and Early Identification

Research supports the implementation of hip surveillance as an effective tool in the prevention of hip dislocation (evidence level 2a).[16] Hip surveillance refers to the process of monitoring and recognizing the important early signs of progressive hip displacement.[3] Early indicators include: GMFCS levels; age; Winters, Gage, and Hicks (WGH) gait classification[19] group IV; and MP on radiological examination.[3]

Recent research supports the use of hip surveillance in children based on their GMFCS level.[9] Past research supports conducting surveillance with all children with spastic quadriplegia as well as all children who are not walking independently by 30 months (evidence level 2a & 2b).[5,16] Others have recommended that surveillance begin as early as 12 months of age (evidence level 4),[15] a recommendation adopted in the guidelines in the Consensus Statement on Hip Surveillance for Children with Cerebral Palsy: Australian Standards of Care (2008).[3]

Surveillance and early intervention should involve both clinical and radiological examinations.

Clinical Examination

A thorough examination of the spine, hips and lower extremities should be completed. Although the relationship between supra- and infra-pelvic deformities is controversial, there is evidence for infrapelvic obliquity (i.e. differences in soft tissue length) preceding the development of suprapelvic obliquity (i.e., scoliosis).[12] It should be noted that although hip range of motion measurements are useful, they are a poor indicator of risk when used alone.[5,17]

Radiological Evaluation

MP using standardized methods of measuring and positioning is considered the best way to determine the degree of hip displacement.[2,16,20] With correct positioning, hip radiographs can provide reliable measurements of the degree of hip displacement.[21] Surveillance includes radiological monitoring to determine MP. The recommended age of first radiograph and frequency of recommended subsequent radiographs vary. Vidal and colleagues (1985) recommend starting radiographs as early as 12 months of age and repeating radiographs every 6 to 12 months until 8 years of age or skeletal maturity (evidence level 4).[15] Since early identification is crucial for the prevention of hip displacement and its consequences, this early start has been adopted in the Consensus Statement on Hip Surveillance for Children with Cerebral Palsy: Australian Standards of Care (2008), with repeat radiography dependent on age, GMFCS level, WGH classification and MP.[3] Soo and colleagues (2006) recommend an initial x-ray at 12 months of age but base repeat radiograph frequency on MP and abduction range of motion (evidence level 1b).[9] If a restriction in abduction range is present or if the MP is greater than 25%, x-rays are recommended every 6 months.[9]

Dobson and colleagues (2002) have recommended a first radiograph at 18 months of age (evidence level 4)[17] while Scrutton and Baird suggest waiting until 30 months of age as data collected at this age correlate much better with hip state at 4 years of age than data collected at 18 or 24 months of age (evidence level 2b).[5] Scrutton and Baird (1997) recommend that all children with bilateral CP, as well as any child who cannot walk more than 10 steps at 30 months, be radiographed to determine MP with repeat imaging every 6 months.[5]

The acetabular index, another radiological measure that describes the shape and development of the iliac component of the hip, may also be of value.[22]

Recently, a classification scale was developed to describe hip morphology in adolescents with CP.[23,24] The classification is a six-point ordinal scale based on MP, integrity of Shenton's arch, deformity of the femoral head, deformity of the acetabulum, and pelvic obliquity.[23] Grades are as follows:[23]

- I: Normal hip – MP < 10%
- II: Near normal hip – MP ≥10% ≤15%
- III: Dysplastic hip – MP >15% ≤30%
- IV: Subluxated hip – MP >30% <100%
- V: Dislocated hip – MP ≥100%
- VI: Salvage surgery

This CP hip classification scale can be used to reliably describe the spectrum of hip morphology for clinical practice and for research.[24]

Interventions

An integrated approach to treatment is recommended to help prevent hip displacement and dislocation, including postural management, orthoses, tone management and surgery. Interventions should be selected in congruence with the child's clinical and functional status, level of pain, hip MP and long term prognosis, as well as social and emotional implications of these factors, financial costs, and outcomes.[25]

Positioning

Recent level 4 evidence suggests that the use of postural management equipment before 18 months of age can help decrease the incidence of hip pathology in children with a GMFCS III, IV or V with bilateral CP and the need for treatment at 5 years of age.[26] Interventions may include positioning for a minimum of 6 hours per day in two or more of the following pieces of equipment: lying support (night use recommended); seating system (six hours per day recommended); standing support (one hour per day recommended.)[26] The effect of 24-hour care on sleep should be considered.[26] In addition, positioning equipment should also be used with any child who cannot walk more than 10 steps by 30 months and has an MP of greater than 15%.[27]

Pountney recommends that specific positioning programs should follow typical gross motor milestone attainment and begin at the following ages:[27]

- A lying program as soon as possible after birth, including periods of prone positioning for play
- A sitting program beginning at 6 months of age
- A standing program beginning at 12 months of age

Programs should include positioning in hip abduction.[27] Early positioning of children under 12 months should also consider that preferred postures, such as supine with the head turned to one side or consistent side-lying, may aid in the progression of asymmetrical postural deformity including hip displacement in children with CP who are non-ambulatory.[28] Care should also be taken to ensure that the child is appropriately positioned within any equipment so that pelvic neutral is achieved in terms of tilt, rotation, and obliquity.[27]

Positioning may also involve the use of braces, such as a sitting walking and standing hip (SWASH) orthosis, to maintain range of motion. Bracing should be used carefully so as not to cause wind-swept hips or a hyperabduction deformity.[9]

Lastly, recent level 4 evidence also suggests that weight-bearing in abduction and extension (straddle weight-bearing) for 30 to 90 minutes per day for one year can reduce MP after adductor-iliopsoas tenotomies in non-ambulatory children with CP as well as prevent an increase in MP in children with CP who did not require surgery.[29]

Tone Management

Botulinum Toxin

Botulinum toxin (BT) is being increasingly used to manage hip migration and reduction of pain in hip displacement, although evidence to support its use in hip management in CP is conflicting (evidence level 1b and 4).[30-33] One randomized controlled trial (evidence level 1b) determined that BT in combination with bracing only offered a very small treatment benefit in the management of hip displacement and that based on these findings, this treatment combination could not be recommended.[32] This interpretation of the study's results is, however, contentious.

Treatment using BT may involve injections to the hip adductors and/or psoas muscles. Injections are typically repeated every 3-6 months and combined with passive stretching and/or abduction splinting.[12] The main disadvantage to using BT is it only offers short term effects and will therefore likely require adjunctive interventions.[11]

Intrathecal Baclofen

Although evidence is limited, intrathecal baclofen has shown promising results in reducing spasticity in children with CP and preventing progression of hip displacement (evidence level 4).[34]

Selective Dorsal Rhizotomy

Selective dorsal rhizotomy (SDR) has been shown to reduce muscle tone. Some evidence exists to support an improvement in MP after SDR but generally only in less affected patients; in patients with a higher GMFCS, MP may increase after SDR (evidence level 4)[35] although this may simply be due to the established relationship between GMFCS level and hip displacement.[9]

Orthopaedic Surgery

Surgery may be required to balance out the muscle forces across the hip joint and optimize the position of the femoral head in the acetabulum to prevent further displacement. Procedures may involve targeting either the soft tissues or bones. When completing orthopaedic procedures, bilateral procedures should be considered to prevent the risk of recurrence or imbalance as unilateral surgery may promote displacement of the contralateral hip.[36, 37] (A thorough review of available orthopaedic interventions is beyond the scope of this brief review.)

Soft Tissue Procedures

The goal of soft tissue procedures is to help prevent continued hip displacement by balancing the muscle forces around the hip and facilitating movement.[12] Soft tissue procedures may be beneficial when the hip is believed to be at risk for dislocation (evidence level 4).[38-41] Examples of those children with hips at-risk include: an MP of greater than 25% with less than 30 to 45 degrees of hip abduction, or an MP of greater than 30% with no bony deformity, or children with higher degrees of MP but below the age of 4 years where bony surgery has a higher risk of recurrence, or in children who have a higher degree of displacement but in whom bony surgery is considered to be too risky.[12] Surgeries vary, but most commonly involve a myotomy of some of the adductor muscles (adductor longus, brevis, gracilis) with or without myotomy of the iliopsoas, the goal being to achieve 30 degrees of abduction.[12]

Other surgeries such as obturator neurectomies are occasionally used although remain controversial.[12]

Bony Procedures

Hip reconstruction is considered in patients for whom soft tissue surgery was not effective, or in those with progressive displacement or dislocation (MP > 40-60%) with or without bony deformity.[12] Reconstructive surgery generally involves a soft tissue release followed by femoral osteotomies with or without pelvic osteotomies.[12]

Some patients may also benefit from an open reduction and capsulotomy, which restructure the acetabulum and proximal femur, and can help maintain the position of the hip.[12,42]

If the femoral head shows signs of deformity or degenerative changes, salvage surgery may have to be considered.[12]

How is hip dislocation treated once it occurs?

Salvage Surgery

With appropriate surveillance programs and early intervention programs that may include preventative surgery, the need for more involved hip reconstruction and salvage surgery can be almost eliminated.[43] When longstanding and painful dislocation is present alongside significant degenerative changes, a proximal femoral resection may be a useful salvage procedure to help improve pain, range of motion, activities of daily living, and quality of life (evidence level 4).[44] Other options include hip athrodesis and arthroplasty or other osteotomies although the evidence for the long-term outcomes of these procedures is lacking.[11] One recent study did, however, find that total hip arthrodeses completed in adolescents and adults with CP (GMFCS I to V) resulted in pain relief and a return to preoperative function at time of follow-up (mean=9.7 years; range=2-28 years; evidence level 4).[45]

Positioning

In some children with dislocated hips, surgery is not indicated or necessary. In these instances, positioning can be used to maintain comfort. When surgical intervention does occur, it is generally followed by splinting in abduction for a period of time[12] and followed by physiotherapy treatment.

How can I facilitate optimal care for children at-risk for hip displacement or dislocation?

Children with CP and similar conditions at risk for hip displacement and dislocation benefit from being followed by a multidisciplinary team to ensure early identification of hip displacement and appropriate referral and intervention. Children at risk should be referred to a paediatrician and/or an orthopaedic surgeon who can complete an appropriate clinical examination and request radiographic imaging as needed. It has been suggested that any child with a MP greater than 15% should be referred to an orthopaedic surgeon[5] while any child with a progression of MP of greater than 7% per year requires careful monitoring and consideration for referral to orthopaedics (evidence level 2a).[15] Others suggest increased radiographic monitoring in children with a MP of greater than 30% as well as those who develop scoliosis and/or pelvic obliquity.[9] A MP of greater than 40% (typical = 10%) or an increase of more than 10% in one year may be used as criteria for preventative surgery (evidence level 4).[17]

Referral to a physiotherapist and/or occupational therapist should also be made to consider positioning interventions.

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Table 1: Oxford Centre for Evidence-based Medicine - Levels of Evidence (March 2009)

Level	Therapy / Prevention, Aetiology / Harm	Prognosis
1a	SR (with homogeneity) of RCTs	SR (with homogeneity) of inception cohort studies; CDR" validated in different populations
1b	Individual RCT (with narrow Confidence Interval)	Individual inception cohort study with > 80% follow-up; CDR" validated in a single population
1c	All or none	All or none case-series
2a	SR (with homogeneity) of cohort studies	SR (with homogeneity) of either retrospective cohort studies or untreated control groups in RCTs
2b	Individual cohort study (including low quality RCT; e.g., <80% follow-up)	Retrospective cohort study or follow-up of untreated control patients in an RCT; Derivation of CDR" or validated on split-sample only
2c	"Outcomes" Research; Ecological studies	"Outcomes" Research
3a	SR (with homogeneity) of case-control studies	
3b	Individual Case-Control Study	
4	Case-series (and poor quality cohort and case-control studies)	Case-series (and poor quality prognostic cohort studies)
5	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"

Table 2: Assigned Levels of Evidence (Consensus Scores)

Area	Reference	Level of Evidence
Incidence	Bagg et al.[6]	4
	Hagglund et al.[18]	2c
	Soo et al.[9]	1b
	Morton et al.[11]	4
Prevention	Hagglund et al.[18]	2c
Surveillance	Scrutton & Baird.[5]	2b
	Vidal et al.[15]	4
	Gordon & Simkiss.[16]	2a
	Dobson et al.[17]	4
X-Ray Guidelines:	Scrutton & Baird.[5]	2b
	Soo et al.[9]	1b
	Vidal et al.[15]	4
	Dobson et al.[17]	4
Referral Guidelines	Scrutton & Baird.[5]	2b
	Gordon & Simkiss.[16]	2a? (SR with queried homogeneity of studies)
	Dobson et al.[17]	4
Intervention Guidelines	Dobson et al.[17]	4
Positioning	Spiegel et al.[12]	5
	Pountney et al.[26]	4
	Pountney.[27]	5
	Martinsson & Himmelmann[29]	4
	Porter et al. [28]	2b
Botulinum Toxin	Pidcock et al.[30]	4
	Placzek et al.[31]	4
	Graham et al.[32]	1b
	Yang et al.[33]	4
Intrathecal Baclofen	Krach et al. [34]	4
Selective Dorsal Rhizotomy	Hicdonmez et al.[35]	4
Soft Tissue Surgery	Spiegel et al.[12]	5
	Pap et al.[38]	4
	Terjesen et al.[39]	4
	Presedo et al.[40]	4
	Stott & Piedrahita.[41]	SR of non-homogeneous AACPDM level III-IV studies
Bony Surgery	Spiegel et al.[12]	5
	Canavese et al.[36]	4
	Oh et al.[42]	4
Salvage Surgery	McClure et al.[43]	5
	Muthusamy et al.[44]	4
	Raphael et al.[45]	4

SR=systematic review; AACPDM=American Academy for Cerebral Palsy and Developmental Medicine