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Spastic hip dysplasia in severe cerebral palsy: Review from the literature

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by

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1   ACKNOWLEDGMENT

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2 INTRODUCTION

Cerebral palsy is a neurodevelopmental condition that could be secondary to hypoxic–ischaemic brain injury during the perinatal period of development or congenital anomalies. Cerebral palsy is the most frequent cause of physical disability in development countries. These patients have motor impairment and also a high rate of mental health problems. Their motor impairments developed unbalanced hip contractures that can lead to silent hip dislocation. The incidence of this complication can be very high, from 15% to 60% (1). There is a relationship with the degree of physical disability and hip dislocation (2). Non-walking patients have a high chance to develop this deformity. The pathogenesis of the progressive hip subluxation from the acetabulum is related to muscular imbalance around the hip. They usually have strong adductors and flexors and unbalanced weak abductors and extensors.

The natural history of the hip dislocation can develop pain, contractures and difficulties with hygiene. Surveillance programmes in cerebral palsy patients can help in detecting at-risk patients for hip dislocation, and early recognition enables early appropriate interventions. The surveillance should be performed with regular radiographic hip examination; because physical examination alone is not a reliable method to mesure hip dislocation . Most physicians agree that preventing hip dislocation is a good way to prevent future problems with hip pain and contracture, providing benefits to the family, caregivers and patient (2). Surgical and rehabilitative approaches, such as soft tissue lengthening and proximal femoral and pelvic osteotomies, can help to maintain hip reduce into the acetabulum.

The rationale of this review is to evaluate recent literature for current trends in the surveillance and treatment of spastic hip problems in patients with cerebral palsy.

3 NATURAL HISTORY

The second most frequent complication in cerebral palsy patients is hip displacement, with an incidence of 15% to 35%. The rate of hip subluxation in this population varies with their functional level. Soo et al. and others authors (1-3) have observed that Gross Motor Function Classification System (GMFCS) level 1 children (community ambulators with minimal disability) have a 0% incidence of hip dysplasia; GMFCS level 2 children (walking limitations on uneven surfaces) have a 15% incidence of hip dysplasia; GMFCS level 3 children (children can walk outdoors or indoors with an assistive mobility device) have a 41% incidence of hip dysplasia; GMFCS level 4 children (children may walk for a short distance on a walker but rely on wheeled mobility) have a 69% incidence of hip displacement; and GMFCS level 5 children (totally involved wheelchair-bound children without head or trunk control) can reach up to 90% incidence of hip dysplasia.

Physical examination may suggest a hip subluxation or dislocation, but an x-ray allows for a final diagnosis. At a physical exam, the following can be found:

  − Loss of range of motion as the first clue.

- − Hip abduction is limited, usually to less than 30 degrees.
- − Hip flexion contracture.
- − Increased internal and decreased external rotation of the hip.

Galeazzi sign refers to the presence of a unilateral hip dislocation, that is, both hips and knees flexed 90° and the thigh on the dislocated side appears shorter than the contralateral side. The relationship between locomotion and progressive hip subluxation was analysed by Scrutton et al.(4). A 30-month-old child who can walk 10 steps alone will not need treatment of his or her hips by the age of 5 years. However, 4.1% of 5-year-old children who can walk 10 steps without help will need hip treatment, and 46% of those who cannot walk at 5 years old will need hip treatment.

We should discuss which are the complications related to hip dysplasia in this group of patients with severe cerebral palsy and if there are some benefits with surgery. As it will be mentioned, great controversy exists with different authors.

There is a relationship between function and hip displacement. Greater displacement has been linked to difficulties with hygiene, ability to be positioned, personal care, walking difficulties, contractures and pain (5, 6).

Pritchett (7) investigated the incidence of hip pain and other complications in relation to treated and untreated hip dislocation at an average of 26 years old patients. He compared 50 patients who were treated for hip subluxation and 50 patients who were not treated for hip subluxation. Both groups had similar incidence of scoliosis and pelvic obliquity, and when evaluating nursing care difficulties, ability to sit and frequency in hip pain, the incidence was similar between the two groups. Approximately 40% of patients in both groups had hip pain, which was classified as minor and did not interfere with daily activities. The conclusion of his research was that treatment of hip luxation in patients with severe cerebral palsy is not helpful and does not offer any benefit to the well-being of the patients.

Noonan (8) reported the prevalence of hip pain in patients with severe cerebral palsy. The study group included 77 patients (154 hips) with an average of 40 years old. Twenty seven percent of these patients have hip dislocated or subluxated, 23% had evidence of osteoarthritis and 18% of the 154 hips were definitively painful. Increase hip pain and perineal care were associated with patients with decrease hip abduction (<30°), windswept hip deformities, spasticity and flexion contractures. The interesting point was that spastic hip subluxation or dislocation was associated with osteoarthritis, but not with hip pain or diminished function. They concluded that surgical treatment of the hip in severely affected patients be based on the presence of pain or contractures, not on radiographic signs of hip displacement or ostheoarthritis.

Knapp et al (9) also search for hip problems associated to hip dislocation en severe cerebral palsy adults. From 29 subjects (34 years old average) with 38 dislocated hips, 71% were not painful. Their advice was to treat only dislocated hip when it becomes painful or develops adduction contracture interfering with perineal care.

Bagg et al (5) reviewed 64 hips in 45 patients after 19 years follow up post surgery. Nine hips dislocated later and those hips were associated to degenerative arthritis, pain and less movement. Interestingly even the reduced hips had 25% of mild pain.

Hodkingson (10) followed 234 cerebral palsy with a mean age of 27 years. Prevalence of hip pain was 47.2%, but he observed that 22% of the hips in place were painful and with or without hip excentration the types of pain were in the same proportions. He concluded that excentration is not the only reason for hip pain, and other causes should be explored.

Boldingh et al. (11) conducted a cross-sectional study on hip radiography and pain in 160 patients. The prevalence of hip pain was 18% and differently as what was discussed by previous authors, they found a correlation between migration of the femoral head, its deformity and pain. Unsuccessful hip surgery was frequently associated with hip pain. Nevertheless they agree that hip pain is a multifactorial phenomenon that cannot be explained by migration and deformity alone.

Finally, it is important to confirm whether hip surgery reduces hip pain in patients with painful dislocated hips and whether it does not induce pain in patients with dislocated hips without hip pain. Krebs et al. (12) reviewed 54 patients with severe cerebral palsy who had 66 severely subluxated hips with a follow up of 4 years 10 months average. When looking at luxated, pain-free hips that were operated on, only 1 of 27 became painful after surgery. When looking at painful luxated hips, 62% became pain free after hip surgery.

Hemiplegic patients have also a threat to develop hip subluxation. Only the group of hemiplegic patients associated with torsional deformities (Winters group 4) is associated with hip subluxation (13). Nevertheless, this complication is rarely developed in this group of patients (14)(Fig. 1).

Figure 1. Hemiplegic type 4. A, pre op; B, post op (pelvic and femoral osteotomy).

A) personal contribution, data A)17.5.2005

B) personal contribution, data 24.2.2016

The difference with quadriplegic patients is that they progress later in time and slower and they can become worse until puberty.

4   PATHOGENESIS

The exact pathogenesis of hip subluxation remains unknown but is most likely a mixture of abnormal tone in the musculature around the hip. Forces of flexion and adduction overpower those of extension and abduction, leading progressively to subluxation, bony abnormalities and lack of normal weight bearing (6, 15). The hip in Cerebral Palsy in contrast to developmental dysplasia of the hip, is not grossly unstable on clinical examination. The hip is subluxated progressively from the acetabulum by the spastic muscle. Forces around the hip are 6 times greater than in a normal hip joint; this was measured by Miller et al. with a computer model (16). The hip anteversion remodels in children with normal neurological development but it persists in patients with cerebral palsy, even into adulthood. The

persistence of this increased anteversion has been associated with progressive hip dysplasia, particularly in non-walking patients.

When reviewing pelvic obliquity and hip subluxation, there are some disagreements. Abel and co-authors reported that the side of the hip subluxation cannot be predicted with the side of pelvic obliquity. They found a relationship with hip subluxation and femoral adduction but not with pelvic obliquity (17). Contrary to this study, Black and Griffin (18) reported that there is a connection with the hip subluxation and that the forces related to the pelvic obliquity were consistent with the forces attached to the pelvic obliquity. In their group of patients, 21 were associated with pelvic obliquity, 17 unilateral subluxations took place on the high side and 4 unilateral subluxations took place on the low side. They concluded that unilateral hip subluxation tends to arise in combination with pelvic obliquity, with most frequent dislocations happening on the high side of the pelvis.

5   X-Ray finding

An x-ray confirms the presence of hip luxation. The changes on the x-ray showing hip subluxation can start to become noticeable at age 2. The risk of hip dislocation is higher before 7 years of age, and what seems a mild hip dislocation can progress to a complete dislocation (4, 19). The deformities seen on the x-ray is an increased neck–shaft angle that can be worsened radiographically with an increased hip anteversion. The lesser trochanter is deformed in elongation because of pulling of the lesser trochanter. As the hip subluxates, the acetabulum changes with increasing acetabular angle, V shape tear drop, sourcil (abnormal weight bearing surface), gothic arch formation of the lateral margin, Shenton line break and erosion of the lateral lip of the acetabulum.

There are also some femoral head changes with superolateral and superomedial notching as a result of pressure from the rim of the acetabulum, the capsule and the ligamentum teres. The muscular spasticity causes the hip deformity and subluxation; for this reason, bony surgery without soft tissue release is useless, and recurrence of hip displacement can occur. In addition, performing soft tissue surgery alone will be unsuccessful when there are bone alterations on x-ray. Robin and Graham (20) described a radiographic classification for hip subluxation in children with CP between the ages of 2 and 7 years; this classification is most commonly used:

1) Grade I hip has a Reimers migration percentage (MP) of less than 10%,
    -Shenton arch intact
    -Femoral head round
    -Acetabulum, normal acetabular development with a normal sourcil, an everted lateral margin and normal teardrop development.
    -Pelvic obliquity <10°

2) Grade II has an MP between 10% and 15%,
        - Shenton arch intact

- Femoral head round or almost round
- Acetabulum, normal or near normal development
- Pelvic obliquity <10°

3) Grade III has an MP between 15% and 30%,
- Shenton's arch intact or broken by <5 mm
- Femoral head round or mildly flattened
- Acetabulum, normal or mildly dysplastic, including blunting of the acetabular margin and a widened teardrop
- Pelvic obliquity < 10°

4) Grade IV has an MP between 30% and 100%
- Shenton's arch broken by more than 5 mm
- Femoral head variable deformity
- Acetabulum variable deformity
- Pelvic obliquity variable

5) Grade V is a dislocated hip in which the MP is greater than 100%
- Shenton's arch completely deformity
- Femoral head variable deformity
- Acetabulum variable deformity
- Pelvic obliquity variable

6) Grade VI is a salvage surgery
- Valgus osteotomy
- Arthrodesis
- Replacement arthroplasty

5.1   X-Ray Measurements

Hip surveillance is not possible with physical exam alone; x-ray, including anterior–posterior pelvis view, is recommended for the early detection and treatment of hip displacement in children with CP (9, 10). The MP (Fig. 2) is accepted as the gold-standard measure in hip surveillance because it can change overtime, and is a critical indicator of progression (1, 3, 4, 21, 22). The hip MP is used to determine the degree of hip subluxation radiographically, as described by Reimers (23). With this method, two lines should be drawn, one that connects both triradiate cartilage (Hilgenreiner) and a second one perpendicular to the previous line that goes from the lateral edge of the acetabulum (Perkins). The percentage of the femoral head lateral of the Perkins line is "the MP". The measurement should be performed in an anterior-posterior pelvis radiograph with the hip in neutral abduction adduction and neutral rotation in relation to the pelvis.

The acetabular index is a measure with the angle formed with two lines, first the Hilgenreiner line just described and the second one, parallel to the acetabular roof.

Figure 2. Migration percentage, MP: A/B × 100%. The drawing is a personal contribution
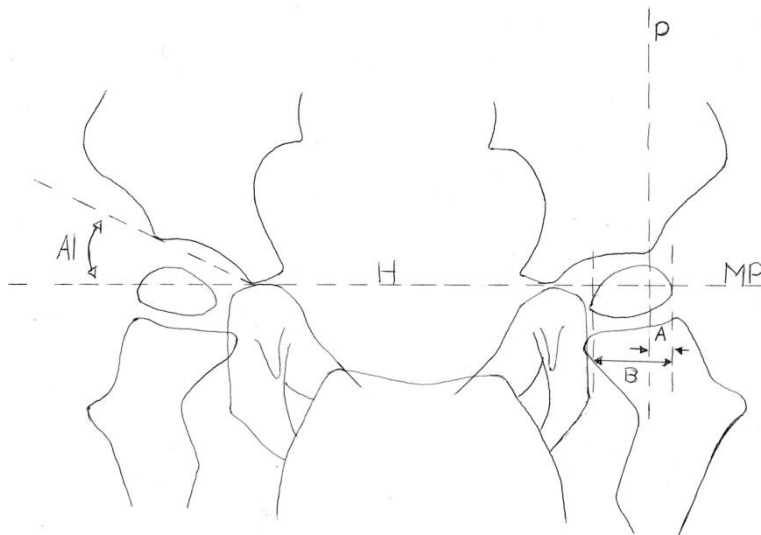
Based on studies of the validity of this measurement, differences greater than 8.3% in MP and more than 3.7° in the acetabular index correspond to a real change in hip displacement with 95% confidence (22, 24). The reliability of the MP improves with growth, allowing hip supervision into adolescence.

The acetabular index varies with the orientation of the pelvis; it can decrease with pelvic anteversion (lordosis) and increases with pelvic flexion. There is also a great variability with rotation. There are no adequate ways to control the pelvic orientation other than clinical positioning; for this reason, the AI is prone to substantial error and is not the first choice for measurement of a progressive hip dysplasia (24). In contrast, Cooke et al. (25) reported that a hip dislocation is always associated to an acetabular dysplasia, and this x-ray change occurs sometime before hip dislocation, because of which they presume that AI is a reliable measurement.

Other measures assessing acetabular dysplasia are the femoral neck-shaft angle and Hilgenreiner epiphyseal angle (HEA), but neither of those is regularly used (26).

6   HIP SURVEILLANCE

Hip surveillance is the process of identifying and monitoring the critical early indicators of progressive hip displacement. These early indicators include GMFCS, age and MP. These indicators will show the risk of hip luxation and the amount of progressive hip luxation. They are essential for a plan to prevent hip displacement and sequela.

Hip pain is difficult to quantify, and for this reason, a radiographically stable hip can be accepted by most physician as absence of hip pain.

Hip surveillance is a process that continues for every child until skeletal maturity.

In 1994, in Southern Sweden, they started a hip surveillance programme for cerebral palsy. The purpose was to identify 'patients at risk for hip dislocation' and to prevent this complication. During the following 10 years, hip dislocation prevalence dropped from 8% to 0.5% (27). Elkamil et al. (27) compared the prevalence of hip dislocation between this Swedish group with surveillance programme and a Norwegian group providing regular care. The prevalence of hip dislocation was 15.1% in the Norwegian group and 0.5% in the Swedish group. In this study, when comparing the two groups, the surveillance programme did not lead to an increase in the total number of hip operations. On the contrary, Dobson (28) showed an increased rate of surgery from 51% to 70.9% when they started with hip surveillance. Most authors showed that the difference when starting with the hip surveillance programme was that children were operated on at an earlier age than children who were offered regular care. The age dropped from an average of 8.3 years to 4.2 years on the surveillance group. (27, 28) Furthermore, with the hip surveillance, the rate of reconstructive hip surgery fell from 37.1% to 29% and the rate of salvage surgery fell from 11.4% to 0% (28).

6.1 TIME TO START WITH THE X-RAY SCREENING

Hip subluxation can start as early as 12 months old, but it does not reach clinical significance (subluxation of MP of 40%) until a few years later (13). For this reason, Scrutton and Baird recommend that severe cerebral palsy patients should have a pelvic radiograph prior to 30 months of age(4).

6.2 RATE OF PROGRESSION

At this point, the literature is not exhaustive, and there is no clear indication for the frequency of x-ray that should be performed to prevent a hip dislocation. Vidal et al. (13) showed that, in those patients who will probably be non-walkers, the annual rate of subluxation is 7.7% and that, in those with walking capacity, the annual subluxation rate reduces to 4%.

Miller and Bagg (19) evaluated age and MP as risk factors for progression of spastic hip subluxation in patients with cerebral palsy. They concluded that patients between 2 to 18 years old with less than 60% of MP need close radiographic follow up to detect hip subluxation.

6.3 TREATMENT INDICATION

There are serious discussions to decide and distinguish between hips that will continue to subluxate and those that will stay stable. Miller et al. (19) found that hips with an MP less than 30% have a low risk of progression, but when this goes up to 30–60%, the risk of dislocation is up to 25%, and preventive surgery is indicated. An MP of more than 60% will

be associated with dislocation, independent of the age of the patient. Hagglund et al. (1) found similar risks for hip subluxation, and they promote hip preventive surgery when the MP is higher than 33% and acetabular angle is higher than 30°. In their study, no hip with an MP more than 42% returned to normal without hip surgery.

There is no clear indication for treatment of hip subluxation; it depends on the degree of hip subluxation (MP), acetabulum index and adductors contractures.

Figure 3: Algorithm of hip treatment. STS, soft tissue surgery, PFO, proximal femur osteotomy. Published by Yildis et al (29)
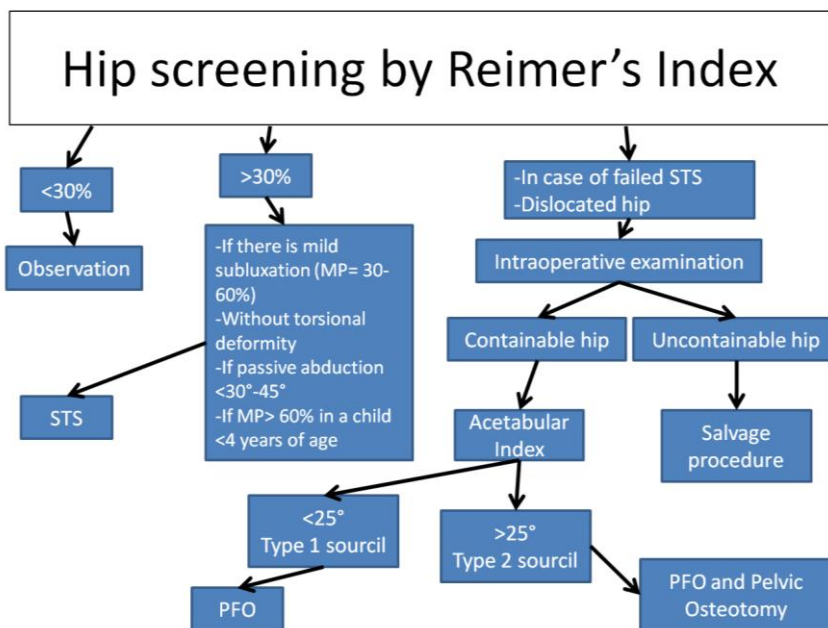
We advocate the Dupont Institute protocol for the hip surveillance (30). The goal is to monitor all children with CP to prevent hip dislocation, with the following monitoring schedule:

   1) GMFCS I and II (full ambulation without assistive device)
- One x-ray after 2 years of age and no more needed if normal
- Exception: Hemiplegia type 4 (with hip involvement), in which x-ray every 2 years from age 8 to skeletal maturity (Fig. 1)

   2) GMFCS III, IV and V (non-ambulatory to walking with assistive device)
- Until age 8, x-ray every year
- Age 8 to skeletal maturity – if previous x-ray normal, then every 2 years
- If previous x-ray MP is >25%, then x-ray every year

7   TREATMENTS

For the incidence of hip subluxation, as was mentioned, in relation to walking ability, the risks goes from 0% at GMFCS type 1 in normal walking patients up to 90% in GMFCS type 5 in totally involved, wheelchair-bound children without head or trunk control. Hip displacement may be painful and lead to difficulties with walking, transfers, sitting, bathing and dressing. Without early detection and treatment, silent hip displacement can progress to painful dislocation. Efforts have been made to characterise the hip displacement Cerebral Palsy patients and to design interventions to reduce hip migration before it becomes severe or symptomatic (11, 31). The hip pain is still a matter of debate and is not fully understood yet, but most authors actually agree to keep the hip reduced regardless of whether it is painful or not. (7, 9-11). Hip surveillance programmes are effective in preventing hip dislocation and reducing the need for salvage surgery, as described before (1).

The goals of treatment include a painless hip that allows stable sitting and positioning in a nonambulatory patient and full hip reduction in an ambulatory patient so that pain-free ambulation can continue. For a hip that is subluxated, surgery is performed in large part to prevent dislocation. Treatments for hip displacement in children with Cerebral Palsy have been classified as follows:

-Complementary and alternative medicine (CAM) was defined as 'no recognized treatments in regular clinical practice'.

-Bracing and spasticity control was defined as 'non-operative interventions to reduce or prevent hip displacement'.

-Preventive surgery was defined as 'soft tissue surgery around the hip without bone procedure'.

-Reconstructive surgery was defined as 'bone surgery with hip and/or pelvic osteotomy and if needed open hip reduction'.

-Salvage surgery was defined as 'loss of the hip acetabulum congruency, and treatment with hip dislocation, excision or replacement'.

7.1   COMPLEMENTARY AND ALTERNATIVE MEDICINE

Willoughby et al. (32) compared the effect of complementary and alternative medicine (CAM approaches in a group of patients that did not accept surgery when proposed and a group that accepted surgery when proposed. The national centre for complimentary and alternative medicine of the national institutes of health in the USA defines CAM as "those approaches and products that are outside the realm of conventional medicine". Some of the CAM approaches mentioned in this article were: Point percussion therapy, Doman Delacato method, Chiropractic, Vojta, Hyperbaric oxygen therapy, Dietary approaches and Stem cell infusion.

They looked at clinical and hip radiographic outcomes for both groups. When analysing the results, there was a clear relation of unsatisfactory results in the CAM group. This group had at least triple the probability of an unsatisfactory Melbourne Cerebral Palsy Hip Classification Scale grade and was more likely to demand reconstructive and salvage surgery. No patient from this group benefitted from a preventive surgery.

When comparing the CAM group with the surgical group, 31% of the first group needed a salvage procedure and none of the surgical group did. Moreover, the results of the surgery on the CAM group were variable, and most of the time, pain could not be relieved. The conclusion of this article was that when parents refuse surgery to prevent further hip displacement, they should stay with clinical control, and whenever symptoms start, surgery could be proposed again.

7.2 BRACING AND SPASTICITY CONTROL

Non-operative interventions to reduce or prevent hip displacement may include postural sleeping systems, seating modifications, abduction bracing and injection of neurolytic agents, such as botulinum toxin A (BoNT-A) and phenol (33). The level of evidence for many of these interventions is limited (34). Historically, emphasis has been on adductor spasticity as the trigger of hip displacement in children with Cerebral Palsy (33). Because of this concept, different treatments were developed to reduce the adductor's spasticity and contractures to improve the range of hip abduction. There is no evidence in the literature of the exact consequences of physical therapy alone altering the progression of hip subluxation.

Although abduction orthosis can help to prevent the loss of acquired range after therapy and adductor tenotomy, compliance with brace treatment is poor, with difficulties with sleeping, and can lead to 'wind-blown' hips or hyperabduction deformity. In addition, Willoughby et al. demonstrated that a previous period of preventive treatment with BoNT-A at the adductors muscle and bracing during 3 years neither reduces the requirement for surgery nor the complexity of the surgery (35).

Other treatment options for spasticity are an intrathecal baclofen pump (ITBP) and selective dorsal rhizotomy (SDR), which are both successful in reducing muscle tone in cerebral palsy. Silva et al. (36) compared hip dislocation rates and reconstructive hip procedures after SDR and ITBP insertion in non-ambulatory cerebral palsy patients, and it was found that neither SDR nor ITBP prevented hip dislocation. They found hip dislocation in 36.2% of SDR and 46% of ITBP, which is in the range value of the natural history of hip dislocation in these types of patients. The decision to have either of these treatments should be based on factors independent of hip subluxation or dislocation. Despite spasticity control surgery, Silva et al. (36) recommend continued surveillance for signs of progressive hip subluxation or dislocation in this group of patients. However, at this time, conservative treatments with spasticity control are not an option for hip treatment (34).

7.3 PREVENTIVE SURGERY

Adductor spasticity as the cause of progressive hip subluxation should be weakened, and this can be performed surgically with muscle myotomy. Muscles that can be cut are the adductor longus, gracilis, adductor brevis (partial or complete) and psoas, lengthening at the lesser trochanter. In case of strong spasticity and a GMFCS 5, neurectomy of the anterior branch of the obturator nerve should be performed. In walking cerebral palsy, the neurectomy of the anterior branch, adductor brevis myotomies and the psoas lengthening at the lesser trochanter should be avoided. Miller et al. (19) noted that improvement of the MP was up to 15% better after surgery, with most improvement seen in the first 5 postoperative months. A recently published study from Shore et al. has shown that the success rate of adductor surgery is predicted by GMFCS level, and the type of adductor surgery is relatively unimportant(37). The success rate of adductor surgery was 32%; in ambulant children, it was high, 94% in GMFCS level 2, and it dropped to 49% in GMFCS level 3. However, adductor surgery had a very high failure rate in non-ambulant children, with a success rate of only 27% in GMFCS level 4 and 14% in GMFCS level 5.

Presedo et al. and others (38, 39) reported an overall higher success rate, from 58% to 83%, for the adductor surgery at long-term follow-up; however, when we divide the success rate with the walking ability, Presedo et al. described 89% for ambulatory subjects and 60% for non-ambulatory subjects.

Figure 4. Two-year-old girl with a severe cerebral palsy, GMFCS type 5. Bilateral adductors and psoas tenotomy was performed. A) personal contribution/data 15.2.2005

B) Same patient 2 years after index operation. personal contribution/data 10.9.2007

C) Same patient 8 years after index operation. Note the improvement in the MP, teardrop and sourcil.
personal contribution/data 18.12.2013

The MP is another predictor of outcome after adductor tenotomy. If the MP was less than 40%, 83% of the hips stayed reduced, but if the MP was higher than 40%, the chance of hip migration after surgery during the following years was close to 77%(38). The same author added that if the acetabular index was higher than 27°, 13 out of 15 hips with adductor tenotomies would be unsuccessful. Bowen and Kehl's study also found that 81% of hips

remained stable at a 7-year follow-up, if the preoperative MP was less than 50% (40). Good results were obtained independent of the age of the patient. (38, 39, 41).

Figure 5. Nine-year-old, severely quadriplegic patient. GMFCS 5. Index operation on left hip.

A) personal contribution/data 9.6.2008
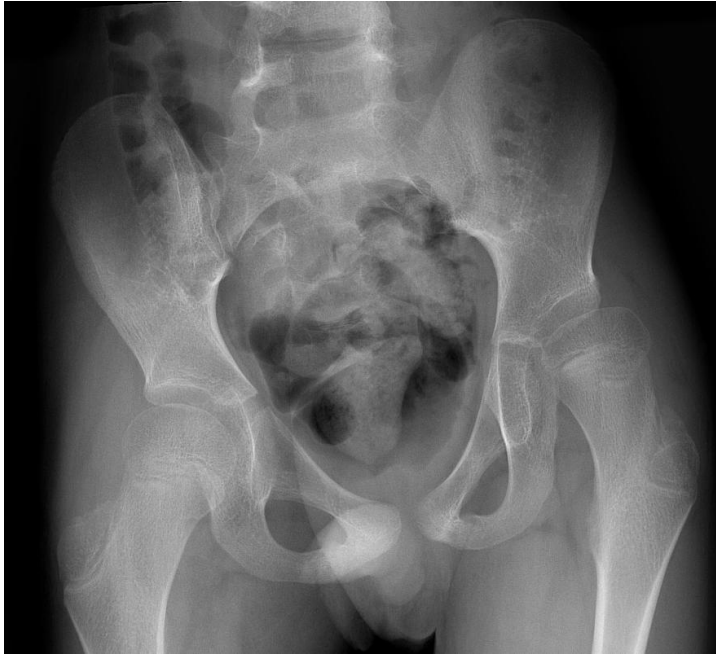
B) Same patient 6 years after index operation. personal contribution/data 16.12.2014

Many patients will require repeated surgery for recurrent subluxation over time, especially if they are non-ambulatory.

The indications for hip adductor tenotomy by Presedo et al. (41) are:

1) Patients ≤7 yr of age
- MP of ≥25% and abduction of ≤30º
- MP of 25–50% and abduction of 31º–45º
- MP of ≥50% and abduction of ≤45º
- Indication for a repeat soft-tissue release MP of 25–40% and abduction of ≤45º

2) Patients ≥8 years of age
- If MP ≥40%, proceed to osseous hip reconstruction

Hip abduction is measured with the child supine with the knees and hips fully extended, as recommended by Rang.

The surgical procedure as described by Presedo et al. (41) consists of adductor longus tenotomy, a complete myotomy of the gracilis and a psoas recession or an iliopsoas tenotomy in ambulatory patients. If after the mentioned tenotomy was done, hip abduction is still under <45°, a partial myotomy of the adductor brevis may be included. If the MP is >40% and the patient has a GMFCS 5, a neurectomy of only the anterior branch of the obturator nerve can also be performed. Postoperative care and procedure should include use of an abduction pillow for 3 weeks both day and night and for 3 weeks night alone, and physiotherapy with adductor strengthening after 1 month. Prone position can be added for psoas lengthening.

7.3.1 COMPLICATIONS

Aside from failure to prevent progressive subluxation and dislocation, complications resulting from adductor surgery and iliopsoas lengthening are few. Infection and haematomas may occur as a result of the dead space created by the surgery and the location of the groin incisions. These complications are seen more frequently after adductor transfers than after releases. A more severe complication is the extension–abduction contractures resulting from adductor–flexor releases. The children had usually previously undergone tenotomy of the iliopsoas and obturator neurectomy at the time of adductor release. Spasticity in the gluteal muscles and hamstrings, which are not released, drives the development of this new contracture, which can cause seating problems because of the lack of hip flexion.

7.4 RECONSTRUCTIVE SURGERY

In the setting of more significant hip subluxation, isolated soft tissue release is inadequate to maintain a stable reduced hip. Indications for hip reconstruction are failed soft tissue surgery and established subluxation or dislocation. The options for hip reconstruction are varus derotation osteotomy and pelvic osteotomy. This could be unilateral or bilateral. Patients who undergo surgical reconstruction of a unilateral dysplastic hip have a debatable risk for subsequent instability in the contralateral hip. Canavese et al. (42) showed that 12 patients (44%) of severely involved individuals with CP undergoing unilateral femoral varus derotation osteotomy (VDO) required subsequent bony surgical management of the contralateral hip for subluxation or dislocation before reaching skeletal maturity. Initially, in all cases, there was pelvic obliquity with the operative side higher, which reversed in cases in

which the contralateral hip deteriorated, and did not reverse when the contralateral hip remained stable. It seems that pelvic obliquity has an incidence on the hip subluxation. The chance of instability of the contralateral 'stable hip' has generated interest in concurrent prophylactic VDO while performing a reconstructive surgery of the unstable hip.

Another point worth noting is that performing surgery on both hips can achieve a more symmetrical length of the lower limb and is easier for correct seating. Furthermore, contralateral surgery may benefit a child with preoperative windswept deformity, a condition characterised by unilateral subluxation and contralateral abduction contracture. In the literature, other authors have a completely different perception of the situation as Larsson et al. (43), who did a similar study as Canavese (42) with a shorter follow-up, with only 8% of contralateral hip subluxation when the index operation was performed on only one side. They recommend bilateral adductors and psoas lengthening to stabilise the pelvis when unilateral osteotomy is performed.

7.4.1.1 INDICATION
At the time of surgery, by evaluating the femoral head, a decision can be made between a salvage or a reconstructive procedure. Most of the time, this decision is already made before the surgery. The indications for hip reconstruction are (29, 44):

1) Femur VDO alone: adductor muscle release failed and a hip subluxation with a MP of > 40% and acetabular index of less than 20°
2) Pelvic osteotomy should be added to the VDO in any child who had dislocated hips (MP > 60% and AI > 25°) for less than 2 years and were either pain-free or had painful dislocated hips with a mild-to-moderate deformity of the femoral head. The older the patient and longer duration of hip dislocation, the higher are the risks of needing a pelvis osteotomy for the acetabulum dysplasia.
3) Hip dislocation >2 years, with deformed head a salvage surgery, should be considered.

7.4.2 FEMORAL OSTEOTOMY
Proximal femoral deformity may consist of increased femoral anteversion and coxa valga. This deformity is progressive and is thought to be directly related to disrupted growth of the proximal femur occurring as a consequence of abnormal loading. Proximal femoral skeletal deformity is addressed by femur VDO. Two techniques could be used to correct the femur deformity. The standard VDO technique termed "end-to-end" (EE) can result in "square pelvis" and in extreme cases may result in breakdown of the surgical incision. An alternative technique for VDO is termed "end-to-side" (ES). (45)

Figure 6. Alternative technique for VDO termed "end-to-side" or ES. personal contribution/data 1.10.2007/18.12.2007
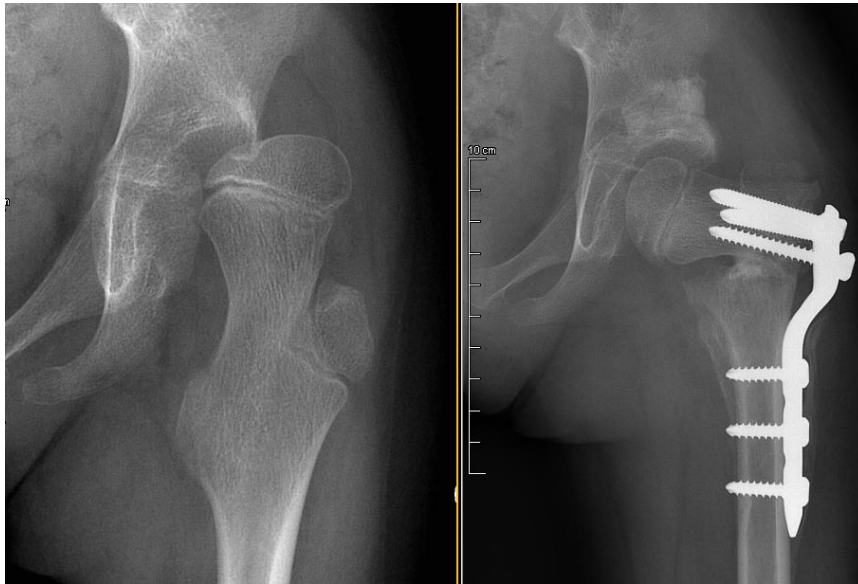
This osteotomy was designed for children with extreme coxa valga to maximise the medial displacement of the femoral shaft. Comparing the two options for the VDO, the rate of complications described by Davids (45) is comparable considering the delay union and osteonecrosis. It seems with the ES technique, there is less protrusion of the plate to the skin. Femur osteotomy fixation could be performed with AO blade plate or paediatric locking compression plate (LCP). Rutz et al.(46) showed that the osteotomies performed with the AO blade plate were finished 17.2 minutes shorter on average, the blood loss was 45.6 mL less, the consolidation rate was better at 6 weeks and the cost is 3 times higher. On the other hand, the grip in osteopenic bone is was stronger in the LCP group. They concluded this as the main indication.

The desired neck–shaft angle after varus osteotomy for hip instability is 90° to 100° of varus in the non-walker and 120° in the walker patients. Release of soft tissue contractures must also be performed to balance the forces across the hip, as described before. After femoral osteotomy and soft tissue release were performed, assessing reduction using fluoroscopy and arthrogram will add information for the decision to proceed with open reduction and/or pelvic osteotomy.

Remodelling of the proximal end of the femur back into valgus occurs with growth, which is most likely in children who are operated on before 4 years of age. No significant remodelling can be expected in patients operated on at 8 years or older. Noonan et al. (47) studied 79 patients at an average of 5 years of postoperative follow-up after VDO and found that 72% remained stable. On the contrary, Schmale et al. (48) monitored 38 young children who underwent VDO at close to the same age, 4 years old, without pelvic osteotomy for hip subluxation and found that 74% required further surgery at a 5-year mean follow-up. Hips that were initially subluxated had better outcomes than dislocated hips did, and also younger

patients were more likely to achieve good results. Other studies comparing outcomes in hips treated by VDO and hips treated by VDO and pelvic osteotomy found superior results with the addition of pelvic osteotomy, and the authors recommended against performing VDO alone.

Femoral shortening should be done to reduce excessive pressure on the femoral head when it is placed in the acetabulum and decrease the risk of avascular necrosis.(49, 50)

7.4.2.1 COMPLICATIONS

Redislocation after VDO was 3% to 5%, and subluxation percentage was 15% to 47% (51). Complications from femoral VDO other than recurrent dysplasia are loss of fixation, fracture, delayed union and non-union; the last are rare but do occur. Heterotopic ossification can result from any hip reconstructive procedure, including varus osteotomy. Patients with spastic quadriplegia who undergo capsulotomy and experience a postoperative infection are at highest risk. Avascular necrosis (AVN) has been documented in some studies in which VDO and a capsulotomy have been added; it can occur to varying degrees, in 0% to 37% of patients (51). Taking care to perform the osteotomy an adequate distance away from the insertion site, for the blade can reduce the incidence of proximal femoral fractures.

7.4.3 PELVIC OSTEOTOMY

In cases in which muscle release and femoral VDRO do not provide adequate coverage or stability of the hip, pelvic osteotomy should also be performed. Pelvic osteotomy should be added most of the time for any child who has dislocated hips with MP > 60% and AI >25°. There are a variety of described operative procedures to address acetabular dysplasia in children. These are divided into those that redirect the acetabulum, such as the Salter and triple osteotomies; those that reshape the acetabulum; the Pemberton and the modified Dega osteotomies; and augmentation procedures, such as the shelf and Chiari osteotomies (described in the salvage procedure). The ultimate goal in any of these is to provide a stable, congruent and functional joint, preferably with normalised anatomy.

Three-dimensional computed tomographic scan (CT) reconstructions of dysplastic hips in patients with Cerebral Palsy have helped to define the nature of the instability (52). Kim et al. reviewed the three-dimensional CT scans of the pelvis in cerebral palsy patients. They found that for subluxation and dislocation different from regular dysplastic hip, most of the time the insufficiency was anterior; in this population, insufficiency was anterior in 29%, superolateral 15%, posterior 37% and mixed 19%. Based on their results, the authors recommended against performing redirectional osteotomies that increase anterior coverage, such as the Salter osteotomy and triple osteotomy, because of the possibility of decreasing the already deficient posterior coverage. Actually, this technique is contraindicated in cerebral palsy patients by many authors, (6, 15) except for the cases with anterior hip subluxation.

Global acetabular deficiency with lack of anterior and posterior wall development and decreased acetabular volume relative to the size of the femoral heads was seen in nonambulatory patients. In this group of patients, reshape osteotomy is the first option.

There are few papers that describe the result with the Pemberton osteotomy in cerebral palsy. This is a reshape osteotomy that covers mostly the anterior colon without changing the posterior colon; nevertheless, Shea et al. (53), using this technique, showed good results without posterior subluxation hips at 10-year follow-ups in cerebral palsy patients.

Most authors actually used the modified Dega osteotomy, San Diego osteotomy (popularised by Mubarak) (54) or periacetabular osteotomy (PO) (popularised by Miller) (55). There are different names for very similar techniques of osteotomy. The modified Dega osteotomy has the great advantage to be versatile and has multiple possible hinges, with the possibility of positioning the graft more anterior or posterior, depending on whether the acetabulum insufficiency is anterior, medium or posterior. The portion hinging on the triradiate accounts for the change in diameter of the acetabulum. One of the most appealing aspects of this osteotomy is that the direction of increased acetabular coverage may be chosen intraoperatively by deciding where to leave intact ilium to act as a hinge.

There are definite theoretical and clinical advantages to the PO: no internal fixation is required, removing the need for a second general anaesthetic for hardware removal. The operation can be safely and effectively performed bilaterally, under the same general anaesthetic if necessary, and does not independently produce leg-length discrepancy. Concerns have been raised that the PO decreases acetabular volume; however, recent analysis by CT and magnetic resonance imaging (MRI) confirms that acetabular volume increases by 56% to 68% and that anterolateral, superolateral and posterolateral coverage improves (56).

Because cerebral palsy patients have more osteopenic bone, which is easily deformable, a PO could be performed even without an open trirradiate cartilage and more mature patient (57). Nevertheless, Brunner described five acetabulum fractures out of 51 hips, and 11% had residual pain doing the PO with closed trirradiate cartilage (57).

7.4.3.1 SURGICAL MANAGEMENT:

The PO extends through the outer table of the ilium from the anterior inferior iliac spine to the sciatic notch. A bicortical osteotomy is performed only at the anterior inferior iliac spine and, with a Kerrison rongeur, at the sciatic notch. The inner table of the ilium is not cut. The lateral osteotomy made through the outer table is extended with curved osteotomes to the triradiate cartilage under fluoroscopic guidance. The osteotomy is then pried down laterally and posteriorly with osteotomes and hinged on the triradiate cartilage, with the inner table of the ilium being left intact. Wedges of bone graft prop the osteotomy open, and the direction of desired coverage is addressed by where one places the bone graft. The sponginess of the triradiate cartilage closes the osteotomy around the bony wedges, so fixation with pins is not usually necessary. A prerequisite for the PO is open triradiate cartilage, even though Brunner described the technique with closed trirradiate cartilage.

7.4.3.2 PERCUTANEOUS APPROACH FOR THE PO

We have recently published the percutaneous approach for a PO (58-60). We have been performing this approach since 2001 (58). We technically started with the hip varus, VDO, and we verified by the end of the procedure with an arthrography that the hip is well reduced to the acetabulum, if it is not the case an open capsulotomy and transverse acetabulum ligament could be cut through the femoral osteotomy as described by Miller (55).

Under fluoroscopic guidance, a vertical line is drawn to represent the roof of the acetabulum. A second horizontal line is the drawn, beginning at the tip of the greater trochanter and goes proximally to the midpoint between the anteriorsuperior iliac spine (ASIS) and the posterior iliac spine (PIS). The intersection between these two lines indicates where the incision should be made, measuring between 2 and 3.5 cm long and parallel to the axis of the femoral shaft.

Superficial and deep dissection through the subcutaneous fat is performed with surgical scissors. The tensor fascia lata is opened longitudinally to its fibres to reach the abductors muscles, in particular the gluteus minimus and gluteus medius. These muscles are rasped from the iliac bone and freed between the ASIS to the sciatic notch. A smooth dissector is slid under the periosteum to the sciatic notch to push apart the soft tissues and protect the nerves.

The pelvic osteotomy is started 5 to 10 mm proximal to the acetabular roof. Under fluoroscopic control, the chisel should appear as a thin straight line, showing that it is parallel to the source of radiation. First, a straight osteotome is used to start the osteotomy, then a curved osteotome to complete the procedure, as has been described in the San Diego osteotomy, and reach the triradiate cartilage. The chisel should cut the outer iliac table with a straight line between the ASIS and downwards towards the sciatic notch. The outer table of iliac bone should be cut, but anteriorly, the inner table can be partially cut to allow more anterior coverage; the osteotomy should be directed towards the triradiate cartilage; the osteotomy should reach but not cross the triradiate cartilage. Once the osteotomy is complete, two straight osteotomes or a Meary spreader may be inserted and used as a lever arm to open the osteotomy site. The same technique could be used with closed triradiate cartilage.

A 2-mm threaded Kirschner wire is inserted into the tricortal allograft to grasp it. Spreading the two osteotomes keeps the osteotomy site open and allows proper positioning of the bone graft (was taken from the femur) into the osteotomy. Once approximately 40% of the graft has passed beyond the outer table of the iliac bone, the osteotomes can be removed and the graft can be pushed with a bone impactor more deeply into the osteotomy. The wire is not used for fixation but to help correctly position the graft.

With this percutaneous technique in 47 hips, we have the same amount of correction as described with the open PO by Miller (55) and Mubarak (54). For complications, we have seen one graft migration and one recurrent dislocation.

7.4.3.3 POSTOPERATIVE:

An abduction brace was used for 3 months. Recently, Ruzbarsky et al. (61) stated that immobilisation in a spica cast after VDO should be avoided, if possible, because of the complications (fractures, ulcers). Recovery time is prolonged after combined soft tissue and bone reconstruction of the hip in children with CP. The interval after surgery until the patient regains the preoperative level of function and experiences pain relief averages 7 to 10 months, but up to 30 months may be needed in rare cases. Parents should be forewarned that surgical improvement will not be seen for some time and that prolonged aggressive postoperative care will be needed. After index operation, 90% of the patients were improved in sitting, nursing and perineal hygiene, as reported by their caregivers (62).

Figure 7. Patient with GMFCS 5, VDO and percutaneous pelvic osteotomy. A) pre op, B) immediate post op and C) 18 months later**.**

A) personal contribution/data 20.6.2013

B) personal contribution/data 28.1.2014
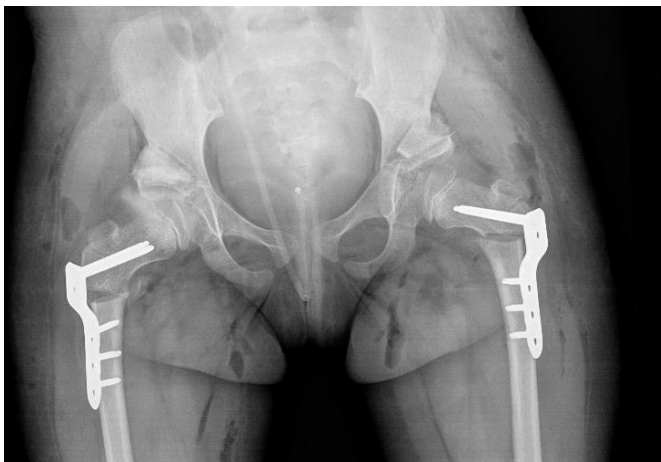
C) personal contribution/data 8.6.2015

7.4.3.4 COMPLICATIONS:

Complications occurred in 25% of all patients (51). Heterotopic ossification and osteoarthritis were infrequent, and the latter was reported only when combined interventions (VDRO + pelvic osteotomy) were performed. The mean percentage of fractures post operation was 6% to 13%, and most of the time this complication happens after cast removal(34). Muaz Al-Ghadir et al. (51) analysed 52 hips, in which 36 had VDO and PO and 16 hips VDO alone. Of the 16 patients who had VDO alone, 25% needed revision procedures, and none of the 36 with combined surgery needed other procedures. In other papers, the subluxation rate after the combined procedure was between 0% and 5% (44, 54, 55). The combined intervention (VDO + pelvic osteotomy) has better results with fewer redislocations than VDO alone.

In cases of resubluxation after the combined procedure, the hip could become extremely painful and a salvage procedure could be the last option. Boldingh et al. (11) found that 12 of 17 patients with failed hip surgery and head deformity became painful. In his cohort, the incidence is 2.7% of VDO and pelvic osteotomy.

The risk factors for resubluxation following surgery are higher in patients who cannot walk (GMFCS levels IV and V), patients younger than 6 years old ($P = 0.013$) and children with a tracheostomy ($P = 0.004$) (51). As discussed earlier, AVN is a recognised complication of hip reconstruction surgery in the CP population. Epiphyseal changes have been seen in up to 10% of patients who undergo femoral osteotomy, as well as in up to 46% of patients who undergo concomitant pelvic osteotomies (61). However, most of the hips with epiphyseal changes will never become painful.

Patients with hip dislocations associated with CP are also frequently malnourished; this augments the risk for postoperative pulmonary complications (respiratory failure, pneumothorax, pneumonia or atelectasis) and the development of decubitus sores from the cast. The 'felt suit' approach to spica casting could be used in cases where femur or pelvic osteotomy are not stable enough to guarantee not further displacement; thick, soft felt is applied to all potential sites of breakdown and bony prominences and held in place with cast

padding. These casts must be well padded because skin sores develop in 15% of these children. Postoperative ulcers were reported in 5% of all patients (34).

7.4.4 CHIARI OSTEOTOMY

Chiari osteotomy was used more frequently during the 1980s and actually is rarely used in cerebral palsy patients (60). It consists of a horizontal osteotomy performed from the sciatic notch to a point just at the superolateral margin of the acetabulum. The distal part of the osteotomy is displaced medially so the hip capsule lies over the lateral bony surface of the ilium, which over time undergoes metaplasia to form fibrocartilage. Although good results have been reported after Chiari osteotomy, it should be combined with femoral osteotomy in patients with severe subluxation. In the latest reports by Zenios et al. (63), 50% of their cases had fair results using Osterkamp criteria, which is quite unacceptable in comparison with others techniques.

Osterkamp criteria:
- Good: Hip is pain free and reduced
- Fair: Hip is subluxed or the preoperative pain persisted or both
- Poor: Hip dislocated or pain increased relative to preoperative level
-

7.4.5 SHELF ACETABULAR AUGMENTATION

Another pelvic procedure that has been widely used is the shelf acetabular augmentation, as described by Staheli in 1981. Technically, a notch is made in the outer wall of the ilium just at the margin of the acetabulum, and cancellous and corticocancellous strips of iliac crest are wedged into this notch above the hip capsule to increase the area of load bearing and therefore improve the stability of the hip. The graft can be located wherever acetabular deficiency is present, thus improving the posterior and lateral deficiencies most common in CP. With this technique, the acetabulum is not redirected; in this manner, coverage is not increased in one direction at the expense of the opposite direction, as happens with the Salter osteotomy. Staheli encouraged that the graft should increase the hip coverage beyond normal.

The shelf acetabular augmentation is indicated for a hip in which spherical congruency cannot be achieved. In hips that remain congruent, a redirectional osteotomy is preferable to maintain coverage by articular cartilage. The shelf procedure is also helpful in hips with global acetabular deficiency and a small articular surface. Studies of the outcomes of shelf procedures in CP patients have shown good results, with hip stability obtained in 83% to 95% of patients(64). The procedure can be useful in some older children with a painful subluxated hip and mild femoral head irregularities.

A complication described with this technique is the resorption of the lateral graft. This was lessened with decortication of the lateral surface of the ilium and radiographic localisation of the inferior lip of the acetabulum, where the shelf needs to be placed. If the graft is placed too high, the acetabulum will appear to have a step-off. Another possible complication is related to the fact that the shelf is built at the very margin of the acetabulum, and it is possible to

disturb further lateral growth of the acetabulum, so the shelf procedure should not be performed in young patients.

7.4.6   Special case: anterior subluxation of the hip

Acetabular deficiencies in cerebral palsy patients include 29% of anterior acetabular deficiency. Children who are at greatest risk for anterior dislocation are those who have excessive adductor and hip flexor release, leading to extension and abduction contractures. Symptoms consist of an inability to sit in a wheelchair because of extension contractures. Half of these patients present with hip pain. The diagnosis is made by physical examination. The femoral head is palpable in the anterior aspect of the groin, and flexion of the hip is limited.

Anteroposterior radiographs may be confusing because the hip may appear reduced as it lies anterior to the acetabulum. The acetabular index and the MP are not sensitive enough to detect the problem because they are based on two-dimensional imaging and are reliable only for lateral and superior displacement of the femoral head. Only a CT scan with three-dimensional reconstruction of both the proximal femur and the acetabulum may aid the diagnosis. This exam is also important for planning an intervention for this complex displacement.

Figure 8. Anterior dislocation of the left hip. personal contribution/data 26.3.2015
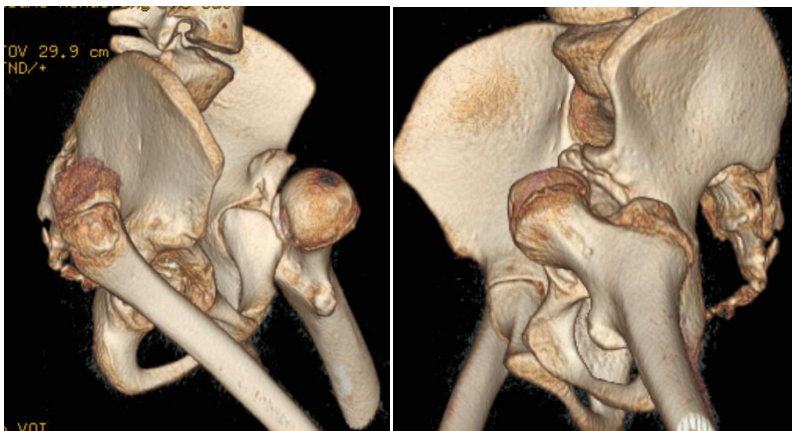
Classic Pemberton osteotomy is the procedure of choice because it is effective for superolateral and anterior acetabular dysplasia. Aggressive muscle release of the proximal hamstrings should be considered and, if the hip is abducted, the abductors and short external rotators must be included in the surgical reconstruction. A varus shortening osteotomy of the femur in conjunction with acetabular osteotomy is recommended to gain anterior coverage but if pain relief is not achieved, the next step should be a proximal femoral resection.

7.5   SALVAGE SURGERY

The approach of early diagnosis and comprehensive treatment in cerebral palsy hips has resulted in significant improvement in long-term prognosis. The painful dislocated hip in cerebral palsy is a challenging problem, which is not completely resolved yet (65-67). The loss of sphericity of the luxated femoral head is secondary to abductor and psoas muscle forces combined with acetabular dysplasia and pressure from the hip capsule. Lateral notching at the femoral head can be caused by direct pressure from the gluteus minimus tendon. The loss of sphericity and the dislocation will lead to degenerative changes in the femoral head. Reduction of the hip will not lead to pain relief but may well exacerbate the hip and groin pain. These degenerative changes can be painful and can affect the patient's quality of life and adequacy of nursing care.

Patients with bony changes in the femoral head are usually older, with most being adolescents. Surgical indications in this group of patients include hip pain, inability to sit in a modified wheelchair and difficulty with perineal hygiene because of contractures. The decision to do a salvage procedure of the hip can be a difficult one to make. The presence of arthritic changes and severe erosion of the femoral head is a clear contra-indication for a conservative surgery. Bleck advocated opening the capsule before reduction in questionable cases and proceeding with proximal femoral resection if the articular cartilage appears to be degenerated. Preoperative MRI can be of use in determining the status of the femoral head in some cases.

Many surgical procedures have been reported to treat this condition, with varying success rates. Salvage options include femoral head and neck resection (66), valgus osteotomy, femoral shortening, soft tissue interposition arthroplasty, McHale procedure (67), arthrodesis and total joint arthroplasty with hip or shoulder prosthesis (65). The backgrounds for arthrodesis, shortening osteotomy and total joint arthroplasty are limited; although promising results have been published, they are lacking in long-term follow-up. All of these procedures are associated with heterotopic ossifications as the main complication; the best treatment for this is still prevention with radiation or nonsteroidal anti-inflammatory drugs. The first is still the best choice (68). Nevertheless, it is rare that a surgical treatment is performed to treat the heterotopic ossification.

7.5.1   FEMORAL RESECTION AND SOFT TISSUE INTERPOSITION

This surgical technique is a resection arthroplasty of the femoral head below the lesser trochanter; it was described by Castle and Schneider in 1978 and later modified by Mc Carthy et al. (69) There is a proximal extraperiostal dissection of the femur, and 3 cm distal to the lesser trochanter the osteotomy is performed. The hip is resected, the capsular flap with the iliopsoas covers the acetabulum and the remaining quadriceps covers the femur stump. Postoperative traction for 6 weeks is recommended.

 More recently, Egermann et al. (70) reported their results using the femoral head as a cap on the proximal femoral stump after resection to produce a more predictable pattern of bony

overgrowth. The patients were placed in traction for 6 weeks postoperatively. They demonstrated a significant decrease in heterotopic ossification and reported that 89% of their patients had a favourable outcome. The result with this technique has been found to improve sitting tolerance, pain in a range from 53% to 77%, with significant drug reduction. Nursing problems also improved; they were close to 100% before surgery, and they were solved in most of the patients.

Recovery from the proximal femoral resection is very long, and it could take up to 1 year to experience pain relief and increased mobility. Families should be warned of this long recovery time. Wheelchair modifications are necessary after proximal femoral resection because the operated leg will be markedly shortened.

7.5.2 COMPLICATIONS

Bone regrowth and heterotopic ossification was found in the literature to be between 0% and 57%. HO tends to exhibit a random and often nonspecific pattern of bone formation. When heterotopic bone blocks motion, it can be resected if mature; usually after 18 months, but it may recur. Proximal migration of the femur occurred in 5% to 28% of cases. A few patients never become completely pain free even after proximal femoral resection and can pose difficult management problems; 9% to 15% of the patients will require surgical revision for persistent pain.

7.5.3 -VALGUS OSTEOTOMY

Valgus osteotomy was described as a method to decrease pain and permit hip abduction for nursing care while eliminating the need for postoperative traction.

This technique was described by McHale et al. (67). The femoral head and neck is resected, and a 45° lateral closing wedge osteotomy is performed just below the lesser trochanter. The osteotomy is held with a plate and screw fixation. The ligamentum teres is sutured to the iliopsoas and lesser trochanter, and a capsulorrhaphy is performed to cover the acetabulum. Neither traction nor postoperative immobilisation is required for these patients. In the literature, it is described that caregivers are satisfied with this technique, but they also described a large amount of complications, 40% to 80% (66, 67). Complications include implant infection, hardware failure and heterotopic ossification. The base of the femoral neck tends to resorb after surgery, and the proximal screws may become prominent, requiring removal of implants. All of these patients improved after the prominent screws were removed.

7.5.4 -INTERPOSITION ARTHROPLASTY

Gabos et al. (71) reported their experience using a cementless shoulder prosthesis as an interposition arthroplasty in non-walking patients with severe quadriplegic cerebral palsy. The technique described by these authors includes a proximal femur resection at the subtrochanteric level, the ligamentum teres and pulvinar is debrided from the acetabulum. A

glenoid component is cemented into the acetabulum, and a shoulder prosthesis is placed in the femoral shaft with cement at the top only to facilitate removal in case of a failure. If a pseudoacetabulum is present on the ilium, it is treated as the acetabulum. The surrounding musculature is sutured to the prosthesis. No other efforts, such as traction or immobilisation, were made to keep the prosthesis in the acetabulum.

In an article by Gabos, 10 of 11 patients (91%) gained complete pain relief at a mean follow-up of 4 years, seating problems were relieved in 45% and nursing difficulties were relieved in all patients.

7.5.4.1 COMPLICATIONS:

The complications described by Gabos and Wright (71, 72) were heterotopic ossification (45%), dislocation (29%), which did not change the capacity of seating and nursing, and femoral fractures (36%). Infection or inadequate resection of femur requiring revision and further femoral shortening were other described complications (72).

7.5.5 -TOTAL HIP ARTHROPLASTY

The ideal candidate for joint replacement is an adult with CP who is able to walk, stand or transfer and should have normal or nearly normal intelligence. Patients should not have coexisting pelvic obliquity or scoliosis. Technical considerations are: (1) a need to position the acetabular component so that it provides posterior stability in sitting patients and (2) frequent loss of acetabular bone stock superolaterally, which requires bone grafting at the time of total hip arthroplasty. The use of constrained implants has led to poor results. Buly et al. (65) reviewed 19 cemented total hip arthroplasty in 18 patients, with a mean age of 30 years. At a mean follow-up of 10 years, pain relief had been achieved in 17 patients (94%) and only three (16%) required revision, two (11%) of which were for recurrent dislocation. Heterotopic ossification was noted in 11 hips (58%) but was not deemed to be clinically significant. Other authors described 6% of aseptic loosening at a 10-year follow-up.

Another option is hip resurfacing. Prosser et al. (73) followed 19 patients (20 hips) treated with this technique, with a mean follow-up of 8.0 years (2.7 to 11.6 years). Eighty-nine percent of the patients or their caregivers were satisfied with the results; nevertheless, there was a high incidence of complications with 10% dislocation, 15% revision for prosthetic loosening fixation and 10% revision for fracture. However, no heterotopic bone was found.

7.5.6 -HIP ARTHRODESIS

Surgical fusion of the hip has been performed in patients with painful dislocations of the hip as a result of surgery failure. They should have normal spines and normal contralateral hips. The desired position of fusion differs from that in the nonneuromuscularly impaired population because the primary position of most of these patients during daily activities is

sitting in a wheelchair; a position of 50° of flexion and 10° of abduction is recommended. Root et al. used a combined intra-articular and extra-articular technique, nearly always together with subtrochanteric osteotomy of the femur, to allow positioning of the leg (74). De Moraes Barros et al. (75) described seven patients with hip arthrodesis. They were severely handicapped with GMFCS level V. Pain was the main symptom, and it was relieved after surgery in all patients. Preoperatively, all patients were bedridden. Postoperatively, five of seven patients were reported to be able to sit in a chair.

7.5.6.1 COMPLICATIONS:

Postoperative complications are fractures in 14% of the patients and non-union in 49%, implant loosening, loss of osteotomy alignment and decubitus ulcer (74, 75) . This technique stays with the last resort for the amount of complications. Its major disadvantage is that it compromises both the sitting and supine positions and increases stress on the lumbar spine.

8   CONCLUSION

Cerebral palsy is a neurodevelopmental condition that can have a variety of degrees of physical disability. There is a relationship with the degree of physical disability and hip dislocation (2). Non-walking patients have a high chance to develop this deformity and secondarily develop pain, contractures and difficulties with hygiene. Surveillance programmes in the cerebral palsy patients can help in detection of at-risk patients for hip dislocation, and the early recognition enables early appropriate interventions.

Conservative treatments do not currently show the capacity to change the natural history. Adductors tenotomy can protect further dislocation if performed early during the dislocation process. Indications for hip reconstruction are failed soft tissue surgery and established subluxation or dislocation. The options for hip reconstruction are varus derotation osteotomy and pelvic osteotomy. This could be unilateral or bilateral.

The decision to do a salvage procedure of the hip can be a difficult one to make. The presence of arthritic changes and severe erosion of the femoral head are the main indications of this procedure.

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