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DEVELOPMENTAL HIP DYSPLASIA: WHAT HAS CHANGED IN THE LAST 30 YEARS?

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Abstract: Developmental dysplasia of the hip (DDH) is a common and important topic in paediatric orthopaedics. Early diagnosis and treatment are critical. Screening for this condition is important. In 1992 year we introduced ultrasound hip screening for all newborns at 4 – 6 weeks of age. Treatment depends on the age of the child and the reducibility of the hip joint. At an early age and up to 6 months the main treatment is an abduction brace like the Pavlik harness. If this fails, gradual reduction using long-term traction and next closed reduction and spica casting have been done.
After the age of 18 month, treatment usually consists of open reduction and hip reconstruction surgery by the Dega method. As compared to the period before the introduction of universal ultrasound, there is now about a 10-fold decrease in severe surgery of dislocated hips. The universal ultrasound screening programme has caused a reduction in the number of surgical interventions.

Introduction

The term developmental hip dysplasia (DDH) describes a whole range of deformities involving the growing hip including frank dislocation, subluxation and instability. The spectrum covers mild defects such as a shallow acetabulum to severe defects such as teratologic dislocations. Teratologic dislocations occur before birth and include severe deformity of both the acetabulum and proximal femur.

Incidence and Risk Factors

DDH incidence depends on how much of the spectrum is included. Dislocated hips are usually diagnosed during infancy, but hip dysplasia may not become evident until adult life and then presents itself as degenerative arthritis. The incidence of a dislocated hip at birth is about 0.5%, the incidence of subluxation and dysplasia is 1%; when implementing universal ultrasound screenings, the reported incidence is 2.5 – 5% [1, 2].

The incidence of DDH is higher in cultures that still swaddle which extends fully and wraps the lower extremities together. Studies of Native Americans showed following a change from traditional swaddling to „safe swaddling" a six-fold decrease in the prevalence of dysplasia [3]. Similar experiences were documented in Japan, Turkey and Poland [4–6]. In „safe swaddling" the infant hips should be positioned in flexion and abduction with free movement.

The breech position is probably the most important risk factor for hip dysplasia [7]. Risk factors include gender, about 80% of the affected children are female due to increased ligamentous laxity as a result of the circulating maternal hormone, relaxin. The left side is involved in 60% of the children, the right side in 20%, and 20% have bilateral involvement [8]. The left side is more commonly involved, perhaps due to the left occiput anterior positioning of most non-breech newborns where the hip is adducted against the mother's spine with limited space for abduction [1]. Other risk factors include first born children, congenital deformities of the lower limbs, intrauterine crowding syndrome and a positive family history [1].

Physical examination

DDH is an evolving process; therefore, the physical examination changes as the child grows. Normal physical examination findings during the immediate postnatal period do not preclude a subsequent diagnosis of DDH [9, 10].

Every newborn should be screened for signs of hip instability. The hip should be examined using both the Barlow and Ortolani techniques [11]. The Barlow test (Fig. 1 A) – hip instability is demonstrated by attempting to displace the hip out of the socket over the posterior acetabulum. The Ortolani test (Fig. 1 B) – the thigh is first adducted and depressed to subluxate the hip, next the thigh is abducted and the hip reduces with a palpable „clunk". The incidence of hip instability declines rapidly 50% within the first week. Later, limitation of abduction and shortening are common (Fig. 2).

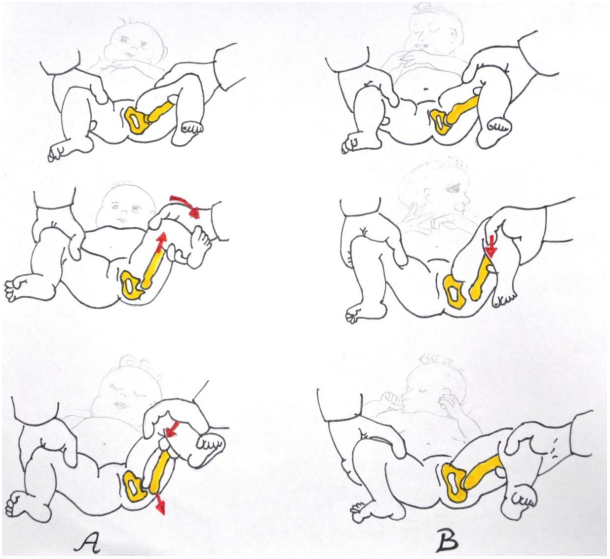

Fig. 1: Barlow (A) and Ortolani (B) maneuver.

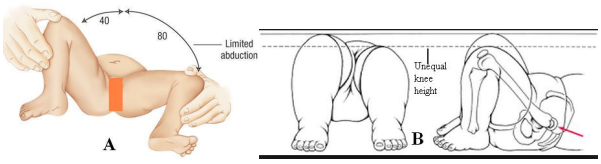

Fig. 2: Limited hip abduction (A) and unequal knee heights (B).

A recent study demonstrated that unilateral limitation of hip abduction after eight weeks of age is strongly associated with DDH [8].

The bilateral dislocations are more difficult to identify. If hip abduction is less than about 60° on both sides, the child should be evaluated by ultrasounds or radiographs.

Ultrasonography

The ultrasound techniques pioneered by Graf include static and dynamic evaluation of the hip joint [12]. This allows the assessment of the static anatomy of the hip and the stability of the femoral head in the acetabular socket. Real-time ultrasonography has been established as an accurate method for imaging the hips during the first few months of life [12]. In patients treated for DDH, a delay in appearance of the femoral head ossification center is commonly seen, even up to 1 year after hip reduction. This allows the utilization of ultrasonographic imaging to be continually used for follow-up [1].

The static technique is performed with the infant in lateral decubitus position and the hip in 35° of flexion and 10° of internal rotation [12]. Morphology is assessed by describing basic anatomic features and angular measurement. The dynamic hip examination is performed following an examination of the hip at rest. The hip is checked for instability, which can be quantified by the measurement of the degree of displacement of the femoral head.

A coronal image of the hip is obtained and 3 lines are constructed (Fig. 3): a vertical line drawn parallel to the ossified lateral wall of the ilium, termed the base line (A); a line drawn from the inferior edge of the osseous acetabulum at the roof of the triradiate cartilage to the most lateral point on the ilium, termed the bony roofline (B); and a line drawn along the roof of the cartilaginous acetabulum, from the lateral osseous edge of the acetabulum to the labrum, termed the cartilage roofline (C). Two angles are calculated. The α angle is formed by the intersection of the base line (A) and the bony roofline (B). The lower limit of normal for the α angle is 60°, the smaller the angle indicates the degree of dysplasia. The β angle is formed by the intersection of the base line (A) and the cartilage roofline (C). The upper limit of normal for the β angle is 55°, if this angle is greater, it means dislocation [12].

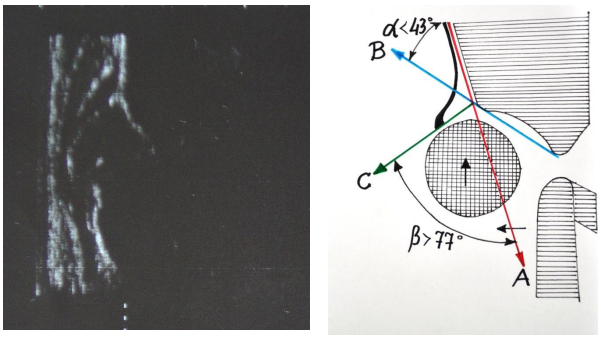

Fig. 3: Ultrasonography Graf type III.

Graf [12] has classified hips according to the measurements based on the degree of femoral head displacement and the associated deformation and the growth retardation of the acetabulum. Type I indicates a normal hip. Type IIa represents an immature hip in an infant who is younger than 3 months with delayed ossification but with a normal cartilaginous roof and an α angle of 50° to 60°. Type IIb refers to a hip with delayed ossification in an infant older than 3 months with a rounded osseous acetabular; an α angle of 50° to 59°, and a β angle of more than 55°. Types IIc, III, IV are pathologic, the acetabulum is severely deficient or poor, and there is lateralization of the femoral head.

Radiography

An anterior-posterior (AP) radiograph is obtained in newborns and infants when other conditions, such as congenital short femur, are suspected. Plain radiography becomes useful for DDH when the femoral head ossification center appears in a child who is over 6 months old. A single AP pelvic view is usually sufficient (Fig. 4). If subluxation

or dislocation is noted, a frog view should be done to assess reducibility.

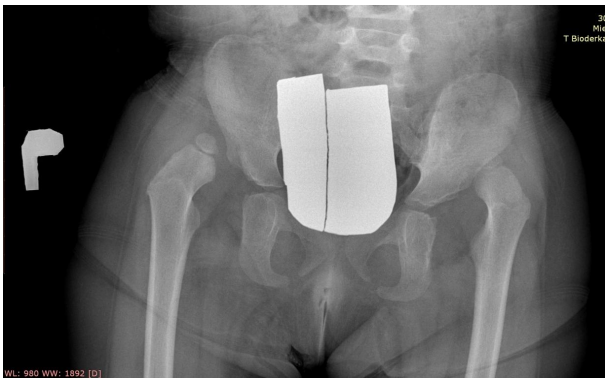

Fig. 4: AP X-ray image of a child with bilateral DDH.

Screening

Different screening programs for DDH are used. There is insufficient evidence in the literature to give clear recommendations for clinical practise [13, 14]. Neither of the ultrasound strategies, universal (screening all infants) versus targeted (only high-risk) have been demonstrated to improve clinical outcomes including late diagnosed DDH and surgery [8].

In German-speaking countries and in Poland, it has been the custom to perform universal screening with ultrasonography, in the United States, there has been less enthusiasm for universal screening.

A study by Mahan et al. [15] concludes that „the optimum strategy, associated with the highest probability of having a non-arthritic hip at the age of 60 years, was to screen all neonates for hip dysplasia with a physical examination and to use ultrasonography selectively for infants who are at high risk". This view is currently the view supported by the Paediatric Orthopaedic Society of North America [16], and this strategy has been introduced in the United Kingdom [17].

Treatment

The management of DDH is challenging. The objectives of management include early diagnosis, reduction of dislocation, avoidance of avascular necrosis, and correction of residual dysplasia. Discussion continues concerning which clinically and sonographically abnormal hips require intervention and at what age.

Birth to 6 Months

Many hips have some degree of instability at birth, which can be detected on an ultrasound, and should be observed for 3 weeks without treatment. Observation is permissible for instability and subluxation up to 6 weeks and for sonographic acetabular growth retardation.

The proper swaddling of the lower extremities during the neonatal period is important.

The Klisic et al. [18, 19] method of wide diapering with the hips packaged in a position of mild flexion and mild abduction has brought in Serbia a significant decrease in the prevalence of congenital dislocation of the hip. The rate of congenital dislocation of the hip fell from 1.3% in years prior to distribution of baby packages to a mean of 0.7% in the ensuing 4 years. During this period, there was a 7-fold decrease in the number of surgical procedures for hip dislocation. Swaddling education has reduced the prevalence of neonatal hip dislocations in many countries [17].

Treatment is indicated in hips that are clinically stable but at 6 weeks still have an abnormal ultrasound. Clarke and Castaneda [17] and authors of this paper consider treatment at 6 weeks if the acetabulum seems morphologically immature if there is instability detected on ultrasound, or an α angle is less than or equal to 57°. Various devices have been used for the treatment. Pavlik harness is widely used orthosis and allows motion in flexion and abduction of hips (Fig. 5). The harness should be carefully fitted and must be comfortable. The physician should check the fit after the parent applied the harness to assess problems before the parent leaves the clinic.

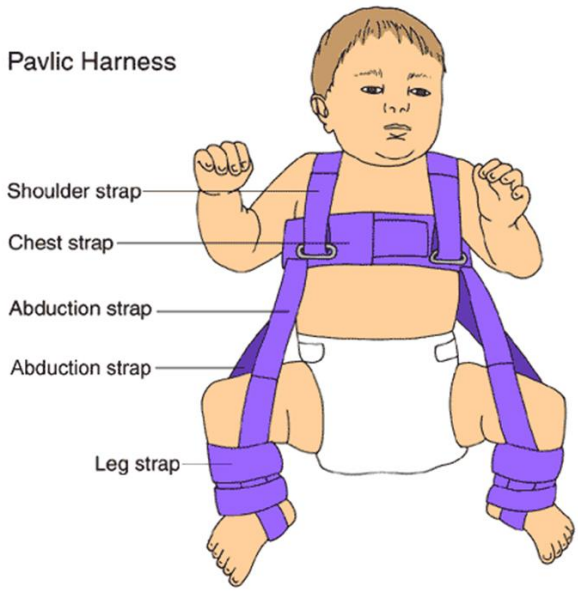

Fig. 5: Pavlik harness.

From 6 to 18 Months

In this group, most cases of DDH can be managed by closed reduction and spica cast immobilization (Fig. 6). A gradual reduction using long-term traction techniques

has been described as a mean of closed reduction. The reported reduction rates were high with a low rate of avascular necrosis (AVN) of the femoral head; however, many of these patients had residual acetabular dysplasia and required future acetabular osteotomy as a secondary procedure [20, 21]. These methods require long traction periods and prolonged hospitalization, which may be difficult for both the children and the family. In some countries, particularly in the US, home traction is proposed, which is less expensive and less stressful for the infant.

Fig. 6: Infant in overhead traction and in spica cast. The hip spica holds the hips in over 90° flexion and approx 60° abduction.

Older than 18 Months

In this age group, operative management is usually required. Open reduction is indicated for all children who failed to achieve a stable concentric reduction of the hip joint by closed techniques. The operative management of DDH is technically challenging. An important decision in the management of DDH is whether to add a femoral or pelvic osteotomy or both to open reduction displacement hip. In Poland Dega osteotomy [22] (Fig. 7) is popular. This technique consists of an incomplete semicircular osteotomy of the iliac bone, in which the osteotomy runs obliquely from the lateral superior to medial interior from a point midway between the anterior superior and anterior inferior iliac spine to just anterior to the great sciatic notch. The osteotomy is opened with osteoclasis of the unosteotomized part of the iliac bone, which keeps the inserted graft under compression without the need internal fixation. This acetabuloplasty is often connected with femoral osteotomy. Femoral shortening is essential in an older child with unreduced DDH [22].

Our Experience

At the Department of Children Orthopaedics of Medical University of Białystok we screen all newborns with ultrasounds; we began in 1992 with an average, 1 500 tests per year. Before that only a clinical physical examination was performed and a radiography was done usually at the age of 3-4 months with clinical evidence of DDH.

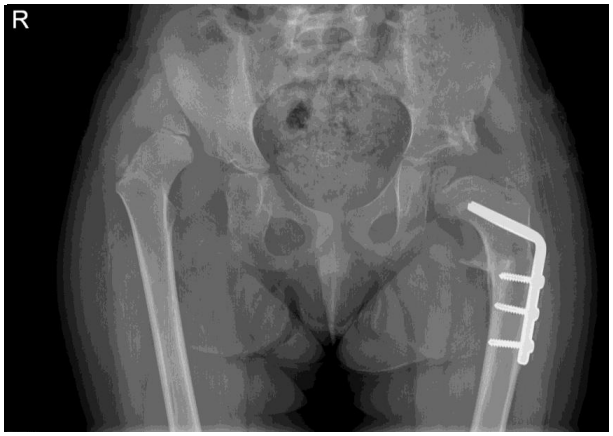

Fig. 7: X-ray image of 4 years old child with bilateral DDH after open reduction and hip reconstruction by Dega method.

The first ultrasound is performed at 4-6 weeks of life because many hips with instability at birth often correct spontaneously. Neonates with mild dysplasia and mild instability noted in the first few weeks of life may have a benign course to spontaneous resolution without intervention. During the first outpatient visit we teach parents the proper care of a child with special attention to maintain abduction position of hips. Particular attention is paid to children with risk factors such as breech birth, female gender, positive family history, congenital deformities of the lower limbs or intrauterine crowding syndrome.

Treatment of dysplasia was dependent on the degree of immaturity of the hip and the age of the child, in which the diagnosis of hip dysplasia was made. We begin treatment of a child at 6 weeks, if the acetabulum is morphologically immature and instability detected on an ultrasound, or an α angle is less than 57°. We generally use a Pavlik harness.

In older child (6 to 18 months) in type III and IV according Graf we use gradual reduction by long-term traction technique and next closed reduction with spica cast immobilization. This method is used to treat about 5 children per year.

An open reduction is indicated for all children older than 18 months, who failed to achieve a stable concentric reduction of the hip joint by closed techniques. A retrospective analysis has been done, which compared the number of surgical interventions before and after the introduction of universal ultrasound screenings (Fig. 8).

Based on this analysis of our material we noticed new trends. In the years 1987-1991 from 25 to 35 children were treated surgically each year with DDH. The ultrasound examination technique of R. Graf in the diagnosis of DDH was introduced as a standard in our clinic in 1992, while from 1992 to 2006 followed by a slow decline in hip operations to an average of 25-10 per year. The number of surgically treated hips decreased steadily and is now at the level of 3-4 per year. These are mainly single late diagnosed dislocation

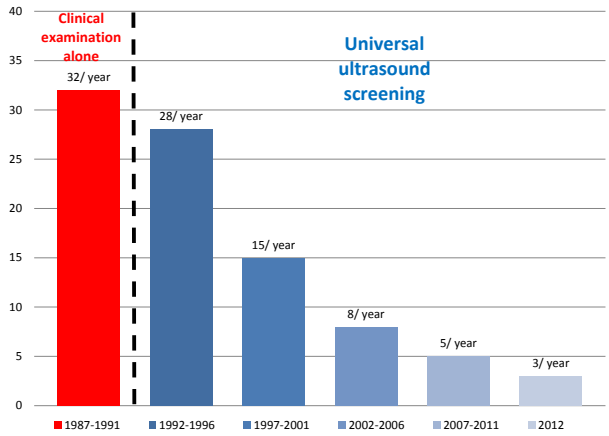

Fig. 8: The number of surgical treatment of hips per year in children in the age of 2-5 years with DDH before and after the ultrasound screening.

or residual dysplasia for correction of extra-articular osteotomy. As compared to the period before the introduction of this screening, there has been about a 10-fold decrease in severe surgery for dislocated hips. A similar result was obtained by Thaler et al. [23]; they reported a 75% reduction in the number of surgical interventions compared with clinical screening alone.

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