Clin Orthop Relat Res (2008) 466:771–775
DOI 10.1007/s11999-008-0132-8

SYMPOSIUM: DEVELOPMENTAL DYSPLASIA OF THE HIP

Neonatal Incidence of Hip Dysplasia

Ten Years of Experience

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Published online: 21 February 2008

Abstract The advantages of sonographic examination are well known, but its main disadvantage is that it might lead to overdiagnosis, which might cause overtreatment. Variations in the incidence of developmental dysplasia of the hip are well known. We ascertained the incidence of neonatal sonographic developmental dysplasia of the hip without considering the development of those joints during followup. All 45,497 neonates (90,994 hips) born in our institute between January 1992 and December 2001 were examined clinically and sonographically during the first 48 hours of life. Sonography was performed according to Graf's method, which considers mild hip sonographic abnormalities as Type IIa. We evaluated the different severity type incidence pattern and its influence on the total incidence during and between the investigated years. According to our study, sonographic Type IIa has major effects on the incidence of overall developmental dysplasia of the hip with a correlation coefficient of 0.95, whereas more severe sonographic abnormalities show relatively stable incidence patterns.
Level of Evidence: Level I, prognostic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Introduction

Developmental dysplasia of the hip (DDH) is one of the most widely discussed abnormalities in neonates. Previously termed congenital dislocation of the hip, DDH encompasses a group of related pediatric hip disorders, including clinical instability of the hip (neonatal or early postnatal), with or without anatomic dysplasia, subluxation, or dislocation. The definition of DDH is a complex and difficult issue. The question is whether all neonates with slight hip abnormalities can be considered as having DDH or does it apply only to those hips that will remain pathologic if not treated. DDH etiology is obscure and seems multifactorial. DDH is associated with genetics, family history, female gender, skeletal abnormalities, and hormonal and environmental factors, making the definition of the problem difficult. Determining the incidence of DDH based on an uncertain definition is even more difficult, and data on the subject in the literature vary widely [15, 16, 26, 28, 29, 31].

The literature on DDH incidence and the way it is diagnosed has changed over the years [4, 6, 27]. At the beginning, before the introduction of routine screening programs for detecting DDH, incidence was estimated at 0% to 40%. Until the 1980s when routine screening for DDH was performed clinically, incidence was 0.41% to

16.8%. Since the 1980s, after the introduction of sonographic techniques for investigation of pediatric hip and neonatal screening, incidence rose to 4.4% to 52%. This wide range of numbers is, as suggested earlier, in part attributable to the varying definitions and diversity between inclusion and exclusion criteria in the protocols used by various authors.

It is now widely accepted ultrasound is the most sensitive method to evaluate infant hips and is sometimes even too sensitive [4, 10, 25]. It is an excellent tool for evaluating acetabular development and for followup during and after treatment. On the other hand, it is well known that sonographic screening of the neonatal hip, combined with clinical examination, can lead to overdiagnosis followed by overtreatment when not used properly [4, 10, 25]. Two principal methods for examining the infant hip by means of sonography have been used recently. The method of Graf [10] is more static but describes the exact anatomic structures of the hip. The method of Harcke et al. [13] is more dynamic, resembling clinical examination under sonographic control. Patel et al. [20] reported most infants with DDH have no risk factors and selective ultrasound screening failed to show benefit.

We believe all neonates should be screened sonographically and clinically examined. In the first 2-year period of this program, we reported a sonographic incidence of DDH of 5.5% [4]. We suggested calling those hips that underwent subsequent treatment "true DDH" and this decreased the incidence to 0.5% [4].

We assessed 10 years of experience with clinical-sonographic neonatal screening for DDH within the first 48 hours of life, without considering the development of those joints in the following years.

Materials and Methods

Since January 1992, each neonate born at our hospital was routinely examined clinically and sonographically for hip abnormality within the first 48 hours of life by experienced neonatologists (clinically) and pediatric orthopaedic surgeons (VB, ME) (sonographically) working independently. From January 1993 until the end of 2001, we examined 45,497 neonates (90,994 hips) clinically and sonographically (Table 1). For this report we excluded 4620 patients (9240 hips) in the first year we started using sonography (1992), because some data were missing from our records (Table 1). No other neonates were included in the study.

The sonographic investigation was performed by the senior author (VB) or under his supervision. Since January 2000, another senior pediatric orthopaedic surgeon (ME) performed the sonographic examinations, first under the supervision of the senior author and later independently. The clinical examination by the pediatric orthopaedic surgeon was performed only when the sonographic examination revealed hip abnormality. We performed the clinical examination as instituted by Ortolani [19] and Barlow [1]. and the sonographic investigation with Graf's method [10, 11] using a 7.5-MHz transducer. Data on family history, gender, other skeletal abnormalities, and so on, were not evaluated, because this was not an epidemiologic study.

Table 1. Number of neonates and hips per year and DDH incidence

Year	Number of neonates	Number of hips	DDH incidence*
1992	4620	9240	Excluded†
1993	4887	9774	514 (5.26)
1994	4321	8642	431 (4.99)
1995	4709	9418	564 (5.99)
1996	4590	9180	484 (5.27)
1997	4640	9280	369 (3.98)
1998	4723	9446	351 (3.72)
1999	4411	8822	301 (3.41)
2000	4293	8586	303 (3.53)
2001	4303	8606	388 (4.51)
Total	45,497	90,994	Mean 4.53%‡

* Values are expressed as number of hips with DDH with percent in parentheses; †data were excluded because some of the details were missing; ‡total DDH incidence; DDH = developmental dysplasia of the hip.

The sonographically abnormal hips were classified by Graf's classification [10, 11]. Graf's method is based on an exact anatomic description of the infant hip using sonography and is divided into four major types (Types I–IV). We considered Graf's Types Ia and Ib as mature joints and Type IIa as physiologically immature. For statistical purposes, we considered Type IIa hips as "pathologic," because they were not fully mature hips, progressing (at least theoretically) to Type IIb or worse.

We first determined the yearly incidences of the different DDH types per year. We evaluated the pattern of total DDH incidence consisting of all the sonographically pathologic hips during the investigated years. The incidence pattern of each type was compared between the years as was the relation and influence of each type on the total incidence. We compared Type IIa with the other severity types (Types IIc, D, III, IV) and their patterns through the years.

Statistical evaluation was with a "crosstabs" chi square. The Pearson correlation coefficient was calculated.

Results

In 1993, the total neonatal incidence of DDH, including Graf Type IIa, was 5.26%, changing and decreasing

Table 2. Incidence of sonographic pathology distribution per year

Year	Type IIa	Type IIc	Type D	Type III	Type IV
1993	239 (2.45)	159 (1.63)	57 (0.58)	41 (0.42)	18 (0.18)
1994	232 (2.68)	117 (1.35)	49 (0.57)	16 (0.19)	17 (0.20)
1995	283 (3.00)	126 (1.24)	96 (1.02)	29 (0.31)	30 (0.32)
1996	221 (2.41)	179 (1.95)	53 (0.58)	20 (0.22)	11 (0.12)
1997	137 (1.48)	143 (1.54)	48 (0.52)	30 (0.32)	11 (0.12)
1998	145 (1.54)	134 (1.42)	47 (0.44)	21 (0.22)	7 (0.07)
1999	91 (1.03)	107 (1.21)	62 (0.70)	36 (0.41)	5 (0.06)
2000	100 (1.16)	116 (1.36)	51 (0.59)	37 (0.37)	4 (0.05)
2001	128 (1.49)	169 (1.96)	46 (0.53)	38 (0.44)	7 (0.08)

Values are expressed as number of sonographically pathologic hips with percent in parentheses.

gradually ($p < 0.001$) until it reached 3.41% in 1999 (Table 2). It increased ($p = 0.08$) again to 4.51% in 2001, still lower ($p < 0.001$) than it was in 1993. Assessing Graf Type IIa separately, the incidence changed similarly, from 2.45% in 1993 decreasing ($p = 0.01$) to 1.48% in 1997 and continuing to decrease ($p = 0.003$) to 1.03% in 1999. In 2000 and 2001, Type IIa incidence increased again, in keeping with the total incidence. Nevertheless, Type IIa incidence was still less than it was in 1993 ($p < 0.001$). The decrease in Type IIa incidence ($p < 0.001$) over the years is expressed by a linear regression line slope (Fig. 1). Sonographic abnormalities other than Type IIa were stable and did not change. Concerning Type IIa, the mean incidence between 1993 and 1996 was 2.63%, decreasing ($p < 0.001$) to 1.31% in the second period. We found no changes between the successive years except between 1996 and 1997 ($p < 0.013$) and between 1998 and 1999 ($p < 0.003$). The pattern of incidence changed when comparing all neonatal DDH with Type IIa during the investigated period (Fig. 2). The constantly changing Type IIa incidence had a major influence on the overall results, whereas Type IIc and more severe sonographic hip abnormalities had relatively stable patterns of incidence. We observed a correlation ($r = 0.95$) between total incidence and Type IIa.

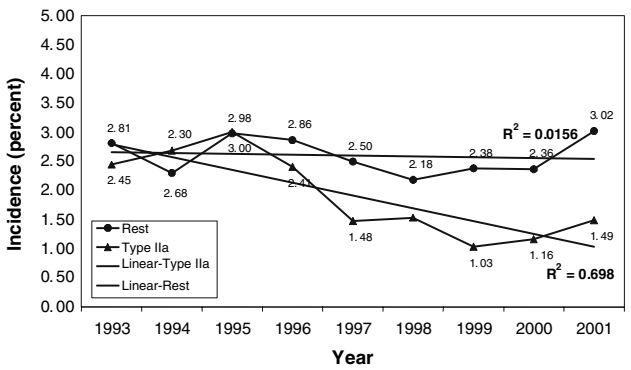

Fig. 1 Sonographic incidence of Type IIa developmental dysplasia of the hip is compared with other hip abnormalities in the assessed period adding the regression lines, which demonstrate the pattern of the incidence changes during the reported years.

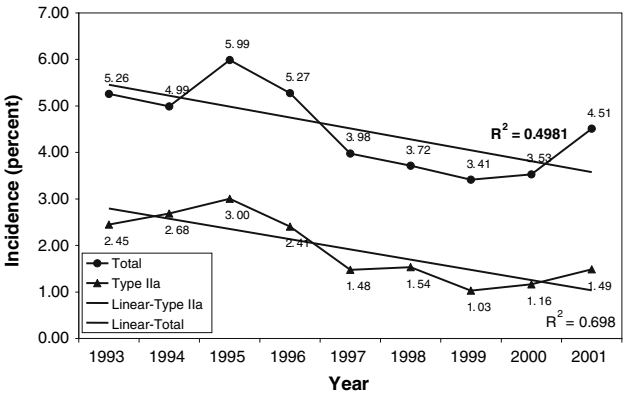

Fig. 2 The incidence of total developmental dysplasia of the hip is compared with the incidence of Type IIa developmental dysplasia of the hip per year adding their regression lines showing the pattern of the changes during the reported years.

Discussion

This study was constructed to ascertain sonographic DDH incidence over a long period of time without considering the later development and treatment of these hips or epidemiologic, demographic, or other factors. Sonography of the pediatric hip is highly sensitive but can lead to overdiagnosis. Using Graf's method of sonography, even minimal anatomic abnormalities can be detected, most of which will not affect the later development of the hip, which will go on to become normal. In a previous study, we suggested overtreatment can be avoided with correct use [4].

The study was limited to assessing incidence only. We did not ascertain any factors that might have influenced the overall incidence of DDH or the relative incidences of the various Graf types (eg, gender, presentation at delivery).

Table 3. Sonographic incidence as reported by various studies

Study	Publication year	DDH incidence (%)	Number of hips screened
Dorn and Hattwich [5]	1987	31.86	1866
Exner [7]	1988	15.3	1230
Ganger et al. [9]	1988	49.87	2582
Pauer et al. [21]	1988	14.97	21,082
Szoke et al. [27]	1988	51.85	4000
Hauck and Seyfert [14]	1990	32	3000
Lotito et al. [18]	1990	20.7	
Reibel et al. [23]	1990	22.6	4290
Tonnis et al. [30]	1990	32.64	5174
Rosendahl et al. [24]	1992	20.68	3006
Reibel et al. [22]	1995	30.52	
Falliner et al. [8]	1996	15.1	
Baronciani et al. [2]	1997	49.7	9296
Bialik and Berant [3]	1997	4.44	
Bialik et al. [4]	1999	5.51	18,060
Toma et al. [29]	2001	4.7	22,652
Kowalczyk et al. [17]	2005	5.7	1944

DDH = developmental dysplasia of the hip.

We have no formal study to examine learning curves, although we believe the data reflect in part a learning curve.

Sonographic DDH incidence using Graf's method as reported in the literature varies between 4.44% and 51.8% (Table 3) [2–5, 7–9, 14, 17, 18, 21–24, 27, 30]. Such incidence rates differ from those reported in previous estimated and clinical screening periods [2–5, 7–9, 14, 17, 18, 21–24, 27, 30]. and are essentially higher than what we call the true incidence of DDH. In a previous study, we reported an overall sonographic incidence of DDH as high as 5.51%. From these, only 0.5% abnormal hips with sonographic DDH did not progress to normal and needed treatment; these were defined as "true DDH" [4]. These data confirm Barlow's statement, suggesting 88% of unstable hips will eventually become normal without treatment [1].

In 2000, another senior pediatric orthopaedic surgeon (ME) joined our unit, and he performed the neonatal hip screening, first under the supervision of the senior author. At the beginning of 2001, he started to investigate neonatal hip sonography independently and, to be on the safe side, considered Type Ib hips as Type IIa. This, in our opinion, explains the increased incidence pattern of DDH from 3.53% to 4.51% in this period based mainly on Type IIa hip incidence changes. Our results are very similar to those published by Toma et al. [29] describing the incidence of DDH according to US investigations as 4.7% and Type IIa incidence as 3.36%.

Our continuing study confirms our earlier contention that the diagnosis of neonatal hip abnormalities carried out during the first days of life are different from true DDH incidence. They are higher but can serve as a baseline for further followup until repeated clinical-sonographic investigation shows a necessity for treatment.

Our data suggest the differences in the incidence pattern of DDH during the years studied were influenced by Type IIa and not by "changing" of the incidence itself. Sonographic incidence of all types except Graf's Type IIa did not change and is close to that reported previously [4, 12]. It is well known that ultrasonographic investigation depends on the examiner's skill and equipment quality. We believe the difficulties are mainly with hips associated with mild or very mild sonographic abnormalities, defined as Type IIa according to Graf's classification. More severe sonographic hip abnormalities are recognized more easily, even by the less experienced investigator. We believe the data suggest an understanding of mild hip sonographic abnormality (Type IIa hips) needs a longer period of training until the investigator achieves enough experience in performing neonatal hip sonography.

Acknowledgments We thank Mrs Myrna Perlmutter for her help in the preparation of the manuscript and Mrs Ronit Leiba for help with the statistical analysis. We are very grateful to the medical staff of the Neonatal Unit who performed all the routine clinical examinations.

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