http:// ijp.mums.ac.ir
Original Article (Pages: 18398-18405)

The Risk of Developmental Dysplasia of the Hip (DDH) in High Birth Weight babies: A Major Risk Factor Detected in the Analyses of Sonograms based on the Graf Technique

* Mohammad Schams [1]

[1] MD, Division of Neonatology, Hirslanden Clinic, Witellikerstrasse 40, CH-8008 Zürich, Switzerland.

Abstract

Background: The purpose of this retrospective study was to check sonographic hip types according to the Graf technique and to compare the results related to large newborns with those related to the normal and small ones based on their Gestational Age (GA); and to investigate the influence of birth weight on the incidence of Developmental Dysplasia of the Hip (DDH).

Methods: Between 1993 and 2003 Ultrasonography (US) of the hips was performed in 7417 consecutive newborns at 34-42 gestational weeks using the Graf method during the first week of life.

Results: The US showed pathological findings in 168 hips (2.3%). 139 of these cases were girls (82.7%) and 29 were boys (17.3%). According to Graf types, there were 63 type IIc, 56 type D, 46 type III, and 3 type IV hips. Except for one boy (type III) all were successfully treated by conservative orthopedic methods. Being overweight (large for GA) in association with breech presentation showed the highest risk for pathological hips requiring treatment (15.6%), followed by normal weight and breech presentation (7.6%), and then came the term newborns large for GA (5%). The lowest percentage need of subsequent orthopedic treatment was in 66 in small newborns for GA with breech presentation (1.5%). There were no associations with DDH in 230 small GA newborns at term, and in 174 twins.

Conclusion: The results, according to the sonographic types, suggest that high birth weight is a major risk factor of DDH, especially when combined with breech presentation; and an almost 5:1 female preponderance was observed.

Key Words: Birth Weight, Gestation Age, Graf Technique, Hip Sonography, Risk Factors.

* Please cite this article as: Schams M. The Risk of Developmental Dysplasia of the Hip (DDH) in High Birth Weight babies: A Major Risk Factor Detected in the Analyses of Sonograms based on the Graf Technique. Int J Pediatr 2023; 11 (12):18398-18405. DOI: **10.22038/ijp.2023.74670.5360**

Corresponding Author:

Mohammad Schams, MD, Division of Neonatology, Hirslanden Clinic, Witellikerstrasse 40, CH-8008 Zürich, Switzerland. Email: moh.schams@gmail.com

Received date: Aug.29,2023; Accepted date: Sep.10,2023

1- INTRODUCTION

Developmental Dysplasia of the Hip (DDH) is a serious and the most frequent developmental disorder of the musculoskeletal system in infants. Ortolani and Barlow tests are standard techniques for clinical detection of hip instability and hip dysplasia in newborns (1, 2). However, immature and dysplastic hips may often be clinically asymptomatic and, therefore, not be detected by manual examinations (3, 4, 7, 10). So, ultrasonographic screening of the hip during the first weeks of life has been established as a gold standard to enable prompt treatment and full recovery of hip dysplasia in several countries (3, 4, 6-16).

Ultrasound (US) of the hip was introduced in 1980 by Reinhard Graf MD (15) in view of early detection of DDH. Quality and standard of hip sonography have since been much improved by higher quality equipment and training (7, 19, 21). Since the introduction of US hip screening, the incidence of late presenting DDH and surgical intervention has been significantly reduced (5, 7, 9-12, 18).

Several authors have advocated screening during the first 6 weeks of life (3, 6, 11, 12). It has been also stated that improved training of doctors would reduce unnecessarily repeated examinations and, thus, costs; and as a result of such training no cases of late presenting DDH were detected (7, 11, 12, 17). The triumph of hip sonography according to the Graf technique, when performed correctly, helps the detection of hips with clinically silent dysplasia which could subsequently develop a dislocation, or persistent dysplasia, if not treated (Graf type IIc). They account for the majority of previously, so called, clinically missed congenital dislocations. Hip ultrasonography can be performed as often as required until about the end of the first year of life, without any risk to the child. This is important for the assessment of therapeutic progress. Ultrasound has virtually replaced conventional x-rays including diagnostic arthrography in the first 6 months of life. Furthermore, the US technique is thought to be more sensitive than clinical examination in the detection of DDH (4, 14).

In German speaking countries, hip ultrasonography is performed by pediatricians, radiologists or orthopedists. The cooperation of these groups is important for the treatment and follow up of Children; also, training of examiners is important to avoid wrong diagnosis and treatment (27).

Ultrasonographic evaluation (US) according to the Graf technique determines the maturation stage of the hip joint by quantifying the bony and cartilaginous acetabular roof with its spectrum of physiological variants (4, 10, 19, 21). It allows for differentiation from pathological morphology, i.e. dysplasia. Moreover, by its dynamic use, it detects the presence of joint instability; and separates pathological and harmless movements (elastic whipping) (19, 21).

2- MATERIALS AND METHODS

From January 1993 to December 2003, hip ultrasound screening according to Graf method was performed during the first week of life (day 2-5) in all newborns (GA 34-42 weeks). All examinations were performed by one experienced ultrasound examiner, the first author (MS), using a 7.5 MHz linear transducer (Siemens Sonoline SI-250).

Amongst the 7417 evaluated newborns, there were 3596 females and 3821 males. All ultrasound data were analyzed retrospectively. Birth weight percentiles were calculated by Denver standards according to Lubchenco (29). Newborns between the 10^{th} and 90^{th} percentiles were classified as normal for GA, those above the 90^{th} percentile as large for GA, and

those below the 10th percentile as small for GA.

A precise diagnosis can only be achieved if the following key steps of the Graf method are carefully fulfilled:

- Correct lateral position of the quiet infant in the cradle and standardized examination is key to a high-quality US image.

- Good visibility of anatomical structures (anatomical identification) and the most important ones include three landmarks in the US image: Lower limb of the os ilium (8.), Mid-Section of the bony acetabular roof (9), and Acetabular labrum (5). For a diagnostic, measurable sonogram, the three landmarks must be present and in a standard plane. Exception: decentred joints.

Hip type's classification according to Graf technique depends on age, degree of ossification and degree of displacement:

1) Type I: mature hip (bony roof angle α above 60°);

2) Type II a: physiologically immature, appropriate for ages below 12 weeks (α= 50-60°);

3) Type II c: critical range, bony roof is severely deficient (α= 43-49°; cartilaginous roof angle β = below 77°);

4) Type D: decentring hip (first stage of dislocation) (α=43-49°; β=above 77°);

5) Types III and IV are dislocated hips (α=below 43°) with cartilaginous roof directed cranially (type III) or caudally (type IV) (4, 10, 19, 21).

If all the hip types with their alpha and beta angles are entered in a line, they provide us with a table called a sonometer. Using this, all joints can be classified according to their types. Alpha value (bony roof angle) determines the hip type, and beta (cartilage roof angle) is responsible for precise differentiation within the type and is used for classification in one circumstance (type II c and type D).

Type II a (α=50-59) joints can be subdivided into type II a (+) or type II a (—), depending on the age. During the first 3 months of life, the hip joint matures in an exponential fashion. In a newborn, the minimum alpha value, that can be expected to become a type 1 by the end of the third month, is alpha 50°. After 6 weeks the hip joint should reach the minimum degree of maturation or more (alpha value of 55° or more) = type II a (+). If alpha is less than 55°, it is called type II a (—) with maturation deficit. The differentiation between type II a (+) and II a (—) should not be made before the 6th week. Type II b, is dysplastic hip with delay of ossification (α= 50°-59°) after 12 weeks Type II a (—) and type II b need orthopedic treatment.

Comparison has been made between newborns with and without risk factors for DDH: breech presentation, twin pregnancy, prematurity, large, normal and small for gestational age (GA) babies, and female sex. Since family data were not consistently available, this risk factor (5, 6, 20) was not included.

With one single exception, one boy (type III), all babies with pathological hips: types IIc, D, III, and IV were successfully treated by conservative orthopedic methods, until their hips became Type I (mature hip) within 2-3 months of therapy. The therapy and follow up of children until the end of puberty has been carried out by two pediatric orthopaedists (co-authors RV and HM).

3- RESULTS

Among 7417 neonates, sonographically mature hips of type I were found in 5.529 (74.5%) and physiological immature type IIa hips in 1.720 cases (23.2%). In 1720 cases there were 1014 girls (13.7%) and 706 boys (9.5%).

In 168 (2.3%) newborns, pathological hips of types IIc, D, III, and IV were diagnosed. Type IIc was found in 63 cases (o.85%) with 54 in female and 9 in male newborns. Type D hips were diagnosed in 56 cases (0.75%), of which 44 were observed in females and 12 in males. Dislocation of the hip (type III and IV) were diagnosed in a total of 49 cases (type III in 46 and IV in 3 cases) with 41 female and 8 male cases. Among these cases which required treatment (n=168) there were 139 girls (3.86%) and 29 boys (0.76%) (**Table 1** and **2**).

Table-1: Sonographic hip types in relation to sex distribution

Variable	Female	Male
Mature hips (type La/lb)	67.94 % (n=2443)	80.76 % (n=3086)
Physiologically immature hips (type IIa)	28.2 % (n=1014)	18.48 % (n=706)
Hips requiring treatment (type IIc, D, III a, IV)	3.86 % (n=139)	0.76 % (n=29)

Table-2: Sonographic hip types: summarized and detailed sex distribution

Sonographic hip types	Total	Grils	Boys
Ia/Ib	5529=74.54%	2443=32.94%	3086=41.60%
IIa	1720=23.2%	1014=13.67%	706=9.52%
IIc	63=0.85%	54=0.73%	9=0.12%
D	56=0.75%	44=0.60%	120.16%
IIIa	46=0.62%	39=0.53%	7=0.09%
IV	3=0.04%	2=0.03%	1=0.01%

Among the newborns with known breech presentation, 15.6% of those diagnosed with pathological hips were large for GA, 7.6% were normal for GA, and 1.5% small for GA.

Among the newborns which were born at term, no case of pathological hips was observed in those small for GA. While 1.8% pathological hips were observed in those normal for GA, and in cases specified as large for GA, there were 5% pathological hips.

In premature newborns there were no pathological hips when they were small for GA. there were 0.7% with pathological hips in those specified as normal for GA and among the cases who were large for GA, there were 2.5% pathological hips.

Twins and newborns that were small for gestational age did not show any pathological hips, even when twins were born large for GA, or had breech position in the uterus.

In addition, among 7417 newborns, 410 had low and 574 high birth weights. Birth weight was differentiated as below 2500 g (low birth weight) and above 4000 g (high birth weight) regardless of GA, sex, intrauterine position, and twin birth.

Normal hips were found in 81.2% of the babies in the low weight group and 46.5% of those in the high weight group. In newborns with a birth weight below 2500g, 18.5% had physiologically immature hips, while this hip type was found in 48, 6% in those babies with birth weights over 4000g. Babies with low birth weight showed 0.2% pathological hips compared to 4.9% in the high birth weight group.

Even low birth weight babies with breech presentation rarely had pathological hips.

4- DISCUSSION

The result obtained from the investigation on this large number of patients confirms the frequency of DDH (2.3) as previously reported (3, 4, 5, 6, 8). According to this study, breech presentation, high birth weight and female sex were found to be clear risk factors for DDH in the newborns, and a combination of these factors increased the risk (5, 6, 20, 23, 24). Female newborn babies showed more pathological hips (4.8 times) and also more physiologically immature hips (1.4 times) compared with males. Almost half of the sonographically pathological hips (48.8%) had known risk factors.

The ethology of DDH is multifactorial. The usual causes of DDH are lack of space and malposition in uterus. Mechanical factors such as breech presentation, high birth weight, oligohydramnios with limitation of fetal mobility in the uterus, applying non physiological shearing forces caudo-cranial on the acetabular roof before ossification, and deform not only cartilaginous acetabular roof, also destroy chondro-osseous junction, which is responsible for impaired ossification and growth of the acetabulum (18, 20, 26).

Other factors with a negative influence on hip development include positive family history, female sex, genetic and socio-cultural factors, vaginal delivery, small uterus, primipara, and older maternal age. Moreover, certain maternal pregnancy hormones such as Relaxin may affect the stability of the hip joint in girls through capsule laxity (5, 20, 22).

Small for GA newborns have no space restrictions in the uterus, resulting in fewer biomechanical forces and, therefore, less pathological hips. Premature newborns and especially twins are usually small and more mobile due to increased amounts of amniotic fluid.

Despite frequent breech presentation, twins have virtually no pathological hips, because they have a flexed position of the knee in the uterus. This position is adapted shortly before delivery; while singletons with breech presentation lie with extended knees in the uterus, for a longer period of time, and with biomechanical restriction (20, 26).

Our results are consistent with the theory that being small for GA protects against hip dysplasia, while being large for GA increases the risk of hip dysplasia, particularly in girls and breech presentation.

Follow up studies on children with initial physiologically immature hips have been performed by several authors. Tönnis et al. (4) showed that 8.9% of physiologically immature hips led to maturity deficits (type II a-) 4-6 weeks after the initial screening. Falliner et al. (3) described that 11% of physiologically immature hips became maturity deficits after 6 weeks and needed treatment.

Some of the published literature reviews on screening for DDH (11, 13, 16, 30) suffer from controversial screening policies in several countries with different screening methods, general screening or screening the at risk for DDH newborns, different times of screening, different technical equipment, and the experience and number of examiners doing the screening process.

According to our experience, it is important to come to an agreement about the standards of an experienced team for clinical and sonographic screening, treatment and follow up of children until the end of puberty. In German speaking countries, hip ultrasonography is performed by pediatricians, radiologists or orthopedists. However, cooperation of these groups is important for the treatment and follow up of children. In addition, knowledge and training of examiners are needed to obtain reliable results (27).

Sonography in the Graf technique and classification, if used correctly, reduces the number of false positive results leading to overtreatment and false negative results associated with late presentations of DDH (7, 10, 12, 19, 27).

5- SUMMARY AND CONCLUSION

Developmental dysplasia of hip (DDH) is a frequent disorder of the newborns (2.3%) with a five-time higher female preponderance.

Breech presentation and being large for GA were found to be the highest risk factors for physiological hip. Then came immaturity and pathological hip followed by normal weight breech position.

None of the twins in this study had pathological hips. Twins had the lowest percentage of physiological hip immaturity among all the listed groups.

Premature newborns rarely have physiological immature or pathological hips.

Small for GA, premature, and twin newborns had no pathological hips.

Large for GA newborns in all groups demonstrated higher percentages of physiological hip immaturity and pathological hips.

High birth weight should be considered as a major risk factor for DDH, especially in combination with other risk factors.

Due to high prevalence of DDH with its significant morbidity, efficiency of early treatment, the known inaccuracy of clinical findings and the difficulties in collecting precise familial data, we recommend, if infrastructure and trained examiners are available, that all newborns should be screened clinically and by ultrasound in the first week of life or at most in the first 6 weeks. About half of the cases requiring treatment will not be diagnosed if general screening is not implemented (3, 4, 10, 11).

If general screening in the Graf technique is not possible, newborns with risk factors for DDH (positive family history, breech presentation, clinical instability of the hip, large for GA and girls) should have ultrasound hip screening during the first week of life, and the remaining newborns during their 4 to 6 weeks of life (7, 10, 11, 12).

6- REFERENCES

1. Ortolani M. Congenital hip dysplasia in the light of early diagnosis. Clin.orthop. 1976; 119; 6-10.

2. Barlow TG. Early diagnosis and treatment of congenital dislocation of the hip joint J Bone joint Surg. 162; 44; 292-301.

3. Falliner A, Hahne HJ, Hassenpflug J. Sonographic hip screening and early management of developmental dysplasia of the hip pediatr Orthop B. 1999 Apr;8(2): 112-7.

4. Tönnis D, Storch K, Ulbrich H. Results of newborn screening for CDH with and without sonography and correlation of risk factors pediatr Orthp. 1990 Mar-Apr; 10(2): 145.52.

5. Bache CE, Clegg J, Herron M. Risk factors for development dysplasia of the hip: Ultrasonographic findings in the neonatal period. J pediatr Orthop B. 2002 Jul; 11(3):212.

6. Mohammad Schams, Rob Labruyere, Anne Zuse, Mikolaj Walensi.

Diagnosing developmental dysplasia of the hip using the Graf ultrasound method: Risk and protective factor analysis in 11,820 universally screened newborns Eur J pediatr 17. July 2017 Springer.

7. Von Kries R, Ihme N, Oberle D, Lorani A, Stark R, Altenhofen L, Niethard FU Effect of ultrasound screening on the rate of first operative procedures for development hip Dysplasia in Germany.

Lancet. 2003 Dec 6, Vol 362(9399): 1883-7.

8. Dorn U, Neumann D. Ultrasound for screening developmental dysplasia of the hip: a European perspective Curr Opin pediatr.2005 Feb: 17(1): 30.3.

9. Synder M, Harcke HT, Domzalski M Role of ultrasound in the diagnosis and management of developmental dysplasia of the hip: an international perspective Orth Clin North Am. 2006 Apr; 37(2): 141-7, v.

10. Graf R, Tschauner Chr, Klapsch W. Progress in Prevention of Late Developmental Dislocation of the Hip by Sonographic Newborn. Hip "Screening": Results of a Comparative Follow up Study pediatr Orthop B: 1993; 2: 115-121.

11. Christoph Thallinger, Renata Pospischill, Rudolf Ganger, Christoph Radler, Christof Krall. Franz Grill Long-term results of a nationwide general ultrasound screening system for developmental Disorders of the hip: the Austrian hip screening program Child Orth0p (2014) 8:3-10.

12. Thaler, R. Biedermann, J. Lair, M.Krismer, F.Landauer Cost-effectiveness of universal ultrasound screening compared with clinical examination alone in The diagnosis and treatment of neonatal hip dysplasia in Austria Bone Joint Surg(Br) 2011; 93.B: 1126-30.

13. Terjesen T, Bredland T, Berg V. Ultrasound for hip assessment in the newborn. J Bone Joint Surg (Br) 1989; 71-B: 767-73.

14. Roovers EA, Boere-ness of ultrasound screening for MM, Castelein RM, Zielhuis GA, Kerkhoff TH Effectiveness of ultrasound screening for developmental dysplasia of the hip Arch Dis Child Fetal Neonatal ED. 2005 Jan; 90(1): F25-3.

15. Graf R. The diagnosis of congenital hip-Joint dislocation by compound treatment. Arch Orthop Trauma Surg. 1980, 117-33.

16. Harcke HT, Clarke NM, Lee MS, Borns PF, MacEwen GD Examination of the infant hip with real-time ultrasonography J Ultrasound Med. 1984 Mar; 3(3): 131-7.

17. Clegg J, Bache CE, Raut VV, Financial Justification for routine ultrasound screening of the neonatal Hip. Bone Joint Surg Br. 1999 Sep, 81(5): 852-7.

18. Tschauner C, Klapsch W, Baumgartner A, Graf R. Maturation curve of the sonographic alpha angle according to Graf of untreated hip joints in the first year of life. Orthop. 1994; 132(6): 502-4.

19. Graf R. Hip sonography Diagnosis and management of infant hip dysplasia Springer Verlag 2006.

20. Graf R, Hammer N, Mathiesen D. An integrated Concept Explaining for Risk Factors Related to the Onset of Developmental Dysplasia of the Hip Joint Ann Orthop Musculoskelet Disord. 2021; 4(1): 1029.

21. Reinhard Graf, Tamara Seidl Sonographie der Säuglingshüfte Georg Thieme Verlag AG 2022.

22. Chan A, Mc Caul KA, Cundy PJ, Haan EA, Byron-Scott R Perinatal risk factors for developmental dysplasia of the hip Arch Dis Child Fetal Neonatal Ed 1997: 76: F 94 -F 100 (March).

23. Holen KJ, Teg nander A, Terjesen T, Johansen OJ, Eik-Nes SH Ultrasonographic evaluation of breech presentation as a risk factor for hip dysplasia Acta Paediatr. 1996 Feb; 85(2):225-9.

24. Von Deimling U, Brähler JM, Niesen M, Wagner UA, Walpert Effect of birth weight on hip maturation in the newborn infants Klin Paediatr. 1998; 210(3): 115-9.

25. Ruhmann O, Lazovic D, Bouklas p, Schmolke S, Flamme CH. Ultrasound examination of neonatal hip: correlation of twin pregnancy and congenital dysplasia. Twin Res. 2000 Mar; 3(1): 7-11.

26. De Pellegrin M, Moharamzadeh D. Development Dysplasia of the hip in twin: The importance of mechanical Factors in the Etiology of DDH J pediatr. Orthop. 2010 30; 774/778.

27. Graf R. Ultrasound examination of the hip. An Update Orthopade. 2002 Feb; 31(2):181-9.

28. Gardiner HM, Clarke NM, Dunn PM A sonographic study of the morphology of the preterm Neonatal hip. J Pediatr Orthop B. 1990 Sep-Oct; 10(5): 633-7.

29. Lubchenco LO, Hansmann C, Dressler M, Boyd E. Intrauterine growth as estimated from liveborn birth-weight data at 24 to 42 weeks of gestation. Pediatrics 32(1963) 793-800.

30. Shipman SA, Helfand M, Moyer VA, Yawn BP. Screening for developmental dysplasia of the hip: a systematic literature review for the US Preventive Services Task Force. Pediatrics 2006; 117.557-576.