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Original Article

Ultrasonographic Screening and the Determination of Risk Factors involved in Developmental Dysplasia of the Hip

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ABSTRACT

Aim: Developmental dysplasia of the hip is an orthopedic problem which is a spectrum of disorders from the instability of the hip joint to total dislocation. Developmental dysplasia of the hip is frequently seen and has good prognosis when diagnosed and treated early. The aim of our study is to examine the risk factors leading to developmental dysplasia of the hip and to assess the value of hip ultrasonography.

Materials and Methods: In our research, 9.102 imagings of hip ultrasonography from 4.551 infants were analyzed retrospectively. One hundred and fifty-one infants who were diagnosed with developmental dysplasia of the hip and 170 healthy infants as a control group were compared in terms of birth order, being the firstborn, type of delivery, gestational age, birth weight, oligohydramnios, multiple pregnancy, breech presentation, swaddling, family history and existence of foot anomalies.

Results: Prematurity, oligohydramnios and a positive family history were observed to be significant risk factors for developmental dysplasia of the hip.

Conclusion: It is possible to prevent the complications and necessity of surgical treatment with early diagnosis. Therefore, we propose screening for developmental dysplasia of the hip for all infants.

Keywords: Developmental dysplasia of the hip, hip dislocation, hip dysplasia, hip instability, hip ultrasonography

Introduction

Developmental dysplasia of the hip (DDH) is defined as a disruption of the relationship between the acetabulum and the femoral head. The traditional term congenital hip dislocation, suggesting a pathology due to the prenatal malposition, has been replaced by the term DDH, as Klisic proposed, emphasizing the dynamic course of the disease (1).

The estimated incidence of hip instability during the newborn period ranges from 1/1.000 to 3.4/100, whereas

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the prevalence of hip dislocation ranges from 1 to 1.5 per 1.000 live births (2).

Various etiological factors including ligamentous laxity, prenatal positioning, postnatal positioning, and racial predilection may lead to DDH (2). Hormonal, genetic and environmental factors have been described in the etiology. DDH in a first-degree relative, breech presentation, swaddling, and congenital calcaneovalgus foot deformities were identified as the strongest risk factors in DDH, whereas female sex, coexistence of torticollis and being the firstborn child were associated with having weaker effects on DDH (3).

The hip joint should be evaluated during routine examination of the newborn.

Ultrasonography is the most reliable imaging method for the diagnosis of DDH before femoral head epiphyseal nucleus ossification. The aim of the treatment is to maintain the normal relationship between the femoral head and the acetabulum and to sustain the reduction until the pathological changes are over.

The purpose of our study is to examine those risk factors leading to DDH and to assess the diagnostic value of hip ultrasonography.

Material and Methods

In our hospital, 9.102 imagings of hip ultrasonography data performed between January 2012 and January 2013 from 4.551 babies were retrospectively analyzed. The records of 170 babies, diagnosed with DDH, were obtained from our hospital registration system.

ToshibaAplio 800, ToshibaAplio 500, General ElectricsLogiq S6 brand ultrasonography devices and 11 MHz linear probes were used for the ultrasonographic examination of the hip. Ultrasonographic classification of the hip joint was performed according to the Graf method (2,4).

Type I: alpha angle: >60° beta angle: <55°,

Type IIa: alpha angle: 50°-59° beta angle: >55° (less than 3 months),

Type IIb: alpha angle: 50°-59° beta angle: >55° (greater than 3 months),

Type IIc: alpha angle: 43°-49° beta angle: <77°,

Type D: alpha angle: 43°-49° beta angle: >77°,

Type IIIa: alpha angle: <43° beta angle: >77° (hypoechoic cartilage acetabular roof),

Type IIIb: alpha angle: <43° beta angle: >77° (hyperechoic cartilage acetabular roof),

Type IV: alpha angle: <43° beta angle: >77° (Pressed downwards, perichondrium is horizontal or dips caudally).

The physical examination findings of patients were evaluated in terms of 'pili asymmetry' and 'limited abduction'. Interviews were held via telephone with the parents to evaluate the follow-up. Data on birth order, sex, type of delivery, gestational age, birth weight, oligohydramnios, multiple pregnancy, breech presentation, swaddling, family history, and foot anomalies were obtained from the hospital registry system and family interviews. In order to determine the relationship between risk factors and DDH, 170 control cases were randomly selected from those infants who underwent hip ultrasonography between January 2012 and January 2013 in our hospital. The control group were questioned concerning the presence of risk factors of DDH and the information was recorded.

Ethics committee approval was received for this study from the Ethics Committee of Ankara Keçiören Training and Research Hospital (25.01.2017/1301). Verbal informed consent was obtained prior to the interviews.

Statistically Analysis

Statistical analyzes were performed using the SPSS for Windows Version 22.0 package program. Categorical variables were compared by chi-square or Fisher's exact test. The significance level was taken as $p<0.05$.

Results

The ultrasonographic findings of 9.102 hips of 4.551 cases, who underwent hip ultrasonography for screening, were examined. We identified a total of 170 cases of whom DDH was detected. Among them, follow-up data could not be obtained for 18 patients. Additionally, one patient was excluded because of the diagnosis of spinal muscular atrophy.

One hundred sixty-nine infants were accepted into this study giving a total of 338 hips. Of the total number of patients, 138 (81.7%) were female and 31 (18.3%) were male. Hip ultrasound examination was performed between the ages of 46 and 188 days (80.3±20.3 days). DDH was detected right sided in 89 cases and left sided in 125 cases. In 45 cases, DDH was bilateral. Ultrasonographic type distribution of each hip (338 hips in total) revealed that 124 (36.7%) were type Ia-b (normal), 16 (4.7%) were type IIa-, 133 (39.3%) were type IIa+, 33 (9.8%) were type IIb, 19 (5.6%) were type IIc, 5 (1.5%) were type D, and 8 (2.4%) were type IIIa. Type IIIb and type IV hips were not detected in any cases (Table I).

In order to evaluate the risk factors, we compared 170 cases constituting the control group with 151 cases who were diagnosed with DDH. Eighty-seven (51.2%) of the control cases were male, and 83 (48.8%) were female. In the control group, hip ultrasound examination was performed between the ages of 54 and 108 days (73±9 days).

On physical examination of those cases diagnosed with DDH, limited abduction was noted in 22 cases (14.6%) and pili asymmetry in 14 cases (9.3%). Physical examination findings of 115 patients (76.1%) were normal. All 7 patients with type IIIa hips had limited abduction, indicating a significant difference. No significant relationship was found between the pili asymmetry and the hip types.

The risk factors commonly associated with DDH including birth order, sex, type of delivery, gestational age, birth weight, oligohydramnios, multiple pregnancy, breech presentation, swaddling, family history, and the existence of foot anomalies were explored. Among these factors, prematurity, oligohydramnios and a positive family history were demonstrated to have a statistically significant association with DDH. A total of 135 patients had at least one risk factor, of whom 103 cases had positive physical examination signs for DDH. The relation between hip types and risk factors is shown in table II and the effect of risk factors on DDH is summarized in table III.

Follow-up information revealed that 52 of the DDH cases were followed up without treatment, 73 were treated with Pavlik harness, 4 with abduction orthosis, 12 with both Pavlik harness and abduction orthosis, 4 with open reduction, 4 with closed reduction and 2 had an operation plan at the time of writing.

Discussion

DDH is an orthopedic problem which is a spectrum of disorders ranging from the instability of hip joint to

Table I. Ultrasonographic type distribution of all hips

	Right hip		**Left hip**		**All hips**	
Type	**Number**	**%**	**Number**	**%**	**Number**	**%**
Ia-b	80	47.3	44	26	124	36.7
IIa-	8	4.7	8	4.7	16	4.7
IIa+	53	31.3	80	47.3	133	39.3
IIb	18	10.7	15	8.9	33	9.8
IIc	6	3.6	13	7.7	19	5.6
D	2	1.2	3	1.8	5	1.5
IIIa	2	1.2	6	3.6	8	2.4
Total	169	100	169	100	338	100

Table II. The relation between hip types and risk factors

	Type Ia-Ib (normal)		**Type IIa**		**Type IIb**		**Type IIc**		**Type D**		**Type IIIa**	
Risk Factors	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Firstborn	75	44.1	50	47.6	8	32	5	45.5	2	66.7	3	42.9
Female sex	83	48.8	86	81.9	21	84	10	90.9	0	0	6	85.7
Caesarean section	83	48.8	44	41.9	17	68	5	45.5	3	100	6	85.7
Prematurity	4	2.4	5	4.8	3	12	1	9.1	2	66.7	1	14.3
Oligohydramnios	8	4.7	10	9.5	4	16	1	9.1	2	66.7	0	0
Multiple pregnancy	2	1.2	4	3.8	1	4	1	9.1	1	33.3	0	0
Breech presentation	6	3.5	11	10.5	1	4	1	9.1	1	33.3	0	0
Swaddling	49	28.8	34	32.4	5	20	5	45.5	0	0	1	14.3
Family history	14	8.2	27	25.7	4	16	4	36.4	0	0	3	42.9
Family history (First degree)	2	1.2	8	7.6	1	4	2	18.2	0	0	1	14.3
Foot anomaly	3	1.8	3	2.8	2	8	0	0	1	33.3	1	14.3

Table III. Impact of risk factors on developmental dysplasia of the hip

	DDH group		Control group		p
Risk factors	n	%	n	%	
Firstborn	68	45	75	44.1	0.869
Firstborn girl	49	32.5	40	23.5	0.075
Caesarean section	75	49.7	83	48.8	0.880
Prematurity	12	7.9	4	2.4	0.030
Oligohydramnios	17	11.3	8	4.7	0.048
Multiple pregnancy	7	4.6	2	1.2	0.089
Breech presentation	14	9.3	7	4.1	0.101
Swaddling	45	29.8	49	28.8	0.848
Family history	38	25.2	14	8.2	0.000
Family history (First degree)	12	7.9	2	1.2	0.007
Foot anomaly	7	4.6	3	1.8	0.199

DDH: Developmental dysplasia of the hip

total dislocation. DDH is a common deformity among the musculoskeletal system abnormalities and successful outcomes can be obtained with early diagnosis and intervention. If not treated early, the cost of treatment and the need for surgery increases exponentially and the chances of success decline (5).

The incidence of DDH has been reported to be between 0.08% and 5.2% in previous studies (6-8). The estimated prevalence of DDH in Turkey ranges between 0.5% and 1.5% (6). The incidence determined by hip ultrasonography screening ranges between 0.86% and 17% (9-16). In our research, the frequency of DDH was found to be 3.71%.

All newborn infants should be examined for DDH during routine examination. DDH in the neonatal period can be diagnosed by eliciting the Ortolani or Barlow sign. By the second month of life, other signs of DDH might become obvious, including limited abduction, asymmetry of thigh folds, Galeazzi sign and pistoning of the hip (2). We did not regard the Ortolani and Barlow tests because our patients had passed the neonatal period. The most reliable examination finding after the newborn period is limited abduction (6,10,11). In our study, limited abduction was noted in 14.6% of infants.

Demirhan et al. (12) detected the ratio of the coexistence of abnormal ultrasonography and pathologic physical examination findings as 40% whereas the ratio of abnormal ultrasonography without clinical evidence was 60%. In the study of Karapınar et al. (13), 15,000 babies were screened regarding physical examination findings and risk factors. Among them, 482 infants with positive physical examination findings and risk factors were assessed with hip ultrasonography and pathologic ultrasonographic findings were observed in 73 (15.1%) cases. Bache et al. (17) reported that only 20% of those patients with abnormal ultrasound findings at 6 weeks of age were found to have unstable hips in the initial examination. Tönnis (18) stated that all newborns should be screened because many pathologies can be detected by ultrasonography rather than other clinical procedures. In our study, we observed that 76.1% of the patients did not display evidence of hip instability on physical examination. Furthermore, we did not find any clinical evidence on 74.7% of infants with dysplasia who required treatment. This suggests the necessity of ultrasonographic screening for DDH even if physical examination findings are normal.

Imaging methods, such as hip ultrasonography, plain pelvis radiography, computed tomography, magnetic resonance imaging, and arthrography, can be used for the diagnosis and monitoring of DDH (2). The specificity and sensitivity of hip ultrasonography in diagnosing DDH is over 90% (19,20). There are various opinions about the time of the screening and postnatal 6th week is defined as a period in which minor transient anomalies of the hip may resolve spontaneously, and early detection of permanent anomalies can be provided (21). Barlow (22) suggested that 60% of unstable hips noted at birth resolved within the first week and 88% in two months. In our hospital, hip ultrasonography is applied as a routine screening program and is usually performed after the first two months of life.

The etiology of DDH is multifactorial, including mechanical structural, mechanical environmental, and

genetic factors (2). In the study of Ömeroğlu et al. (10), infants who had at least one risk factor conducive to DDH were found to have a three times higher occurrence rate of DDH compared to those who did not carry any risk factors. In the same study, breech presentation and positive family history were determined to be the most common risk factors associated with DDH. The incidence of DDH was 27% in infants with at least one risk factor and 9% in infants without any risk factors. (10) In the study of Akman et al. (23), female gender, oligohydramnios, and swaddling were defined as risk factors for DDH. Uslu et al. (24) found that the frequency of hip immaturity among a group of patients exposed and unexposed to the risk factors at 25.2% and 9.9%, respectively. The same study also indicated that the incidence of hip dysplasia was 5.29% in the risk group, whilst no hip dysplasia was encountered in the control group. Furthermore, they demonstrated a correlation between the number of risk parameters and the incidence of immature or dysplastic hips during the newborn period. According to a study by Çakır et al. (5), the most frequent risk factor was identified as being a firstborn girl, followed by breech presentation, multiple pregnancy, and oligohydramnios. Breech presentation, oligohydramnios, female sex, and primiparity were determined to be risk factors for DDH in the study of Chan et al. (25). The meta-analysis of De Hundt et al. (26) indicated that breech presentation, female sex, positive family history, and clicking hips at physical examination were the most potent risk factors for DDH. In our study, prematurity, oligohydramnios, and positive family history were confirmed as statistically significant risk factors. Birth order, being a firstborn, type of delivery, birth weight, multiple pregnancy, breech presentation, swaddling, and the presence of foot anomalies were not found to be statistically significant for DDH.

In the literature, DDH is found to be 4-6 times more common among girls than boys (17,27,28). In our study, the female/male ratio was 4.4/1, which is consistent with the literature.

Delays in diagnosis and treatment resulting in sequelae increase the cost of treatment. Furthermore, total hip arthroplasty may be necessary owing to the development of coxarthrosis. This condition prolongs the treatment process and leads to serious labor force loss. In cases of early diagnosis and conservative treatment, the necessity of surgical treatment can be reduced. Therefore, hip ultrasonography has been included in the screening program and adopted as a health policy in various countries. In our country, within the national early diagnosis and treatment program for DDH, it is aimed to perform a routine hip examination during the newborn period, identify high risk and clinically suspected groups and to initiate early and appropriate treatment (29). Additionally, in our hospital, hip ultrasonography is applied to all infants as a part of the routine screening program.

Study Limitations

The limitations of our study include the small number of patients and the presence of patients whose follow-up information was not available. Additionally, there is a possibility that the information received from the parents of the patients may be incorrect due to misremembering.

Conclusion

Hip joint evaluation with regard to DDH in each visit, careful follow-up of infants with risk factors and family education about the influence of swaddling are important measures to prevent the development of DDH. Awareness concerning DDH among health professionals and parents plays a key role in preventing this condition. Training of health personnel in the identification of those high-risk babies is required for the early diagnosis and treatment of DDH.

Ethics

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Ankara Keçiören Training and Research Hospital (25.01.2017/1301).

Informed Consent: Verbal informed consent was obtained prior to the interviews.

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Authorship Contributions

Surgical and Medical Practices: G.Ü.D., S.K., Concept: G.Ü.D., S.K., E.S., Design: G.Ü.D., Y.T.Y., U.O., Ş.B., Data Collection or Processing: E.S., U.O., Ş.B., Analysis or Interpretation: G.Ü.D., S.K., Ç.Ü., Y.T.Y., Literature Search: G.Ü.D.,U.O., Ş.B. E.S., Writing: G.Ü.D., E.S., S.K., Ç.Ü., Y.T.Y., U.O., Ş.B.

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