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ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

The Relationship between Skin Creases and Developmental Dysplasia of the Hip in Term Infants Undergoing Hip Ultrasonography

Kalça Ultrasonografisi Yapılan Miadında Doğmuş Bebeklerde Gelişimsel Kalça Displazisi ile Pili Asimetrisi Arasındaki İlişki

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ABSTRACT

Aim: We aimed to reveal the relevance between the anterior skin crease (ASC) and posterior skin crease (PSC) and Developmental dysplasia of the hip (DDH) and to reveal its value in predicting the presence of DDH.

Material and Method: Our study included 520 term infants in our study who presented to the pediatric clinic for the first time between 2020/2023 and were between 4-12 weeks of age. ASC-positive and ASC-negative and PSC-positive and PSC-negative groups were compared according to clinical characteristics.

Results: DDH was 6.58% (34/520). The presence of ASC and/or PSC was found in 6.58% (34/520). Female gender, breech presentation and family history of DDH were more common in ASC-positive and PSC-positive groups. Sensitivity for DDH was 26.5%, Specifity for DDH was 95.9%, positive predictive value (PPV) for DDH was 31% and negative predictive value for DDH was 94.9% in ASC+PSC group.

Conclusion: This study has shown that skin folds, which are a simple physical examination finding, are important to exclude the diagnosis of DDH but not to diagnose DDH.

Keywords: Developmental dysplasia of the hip, anterior skin crease, posterior skin crease.

ÖZ

Amaç: Ön deri kıvrımı ve arka deri kıvrımı ile Gelişimsel kalça displazisi (GKD) arasındaki ilişkiyi ortaya koymak ve bunun GKD varlığını tahmin etmedeki değerini göstermeyi amaçladık.

Gereç ve Yöntem: Çalışmamıza 2020/2023 yılları arasında çocuk polikliniğine ilk kez başvuran, 4-12 haftalık miadında doğmuş 520 bebek dahil edildi. Ön deri kıvrımı pozitif ve Ön deri kıvrımı negatif gruplar ile arka deri kıvrımı pozitif ve arka deri kıvrımı negatif gruplar klinik özelliklerine göre karşılaştırıldı.

Bulgular: GKD %6,58 (34/520) idi. Ön deri kıvrımı ve/veya arka deri kıvrımı varlığı %6,58 (34/520) oranında bulundu. Kadın cinsiyet, makat geliş ve ailede GKD öyküsü Ön deri kıvrımı pozitif ve arka deri kıvrımı pozitif gruplarda daha yaygındı. Ön deri kıvrımı + arka deri kıvrımı grubunda GKD duyarlılığı %26,5, GKD özgüllüğü %95,9, GKD pozitif öngörü değeri %31, GKD negatif öngörü değeri %94,9 olarak belirlendi.

Sonuç: Bu çalışma, basit bir fizik muayene bulgusu olan deri kıvrımlarının GKD tanısını dışlamada önemli olduğunu ancak GKD tanısı koymada önemli olmadığını göstermiştir.

Anahtar Kelimeler: Gelişimsel kalça displazisi, ön deri kıvrımı, arka deri kıvrımı.

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INTRODUCTION

Developmental dysplasia of the hip is one of the most important musculoskeletal problems in newborns. Although it is defined as congenital hip dysplasia, this is not an accurate definition because it is essentially a developmental problem. It can lead to hip dislocation and luxation as the proximal femur and acetabulum are affected. It is known that if DDH is left untreated, a significant proportion of hip replacement surgeries in adulthood are due to it. Early diagnosis is important to reduce potential morbidities (1). While the prevalence of DDH varies from 0.8% to 2% worldwide, there are publications reporting a prevalence of 0.5% to 1.5% in our country, although there are not enough epidemiological studies (1,2). It is more common in female gender. It is also more common on the left hip than on the right hip (3). Breech presentation, first birth, multiple pregnancy, oligohydramnios, foot deformities, and family history are known risk factors (4). With the introduction of the ultrasound-based method and the classification defined by Graf, the diagnosis of DDH and failure to detect hip dysplasia have decreased (5,6).

In neonates with DDH and in infants younger than three months, asymmetry of the thigh or groin folds, shortened limbs, and adduction contracture of the dysplastic hip are among the findings that may be observed on physical examination. In dislocation of the femoral head, the inguinal folds are asymmetrical and the skin fold of the affected side extends posteriorly and laterally to the anal opening. In bilateral dislocation, these folds may be symmetrical. Adduction contracture is usually absent in neonates with DDH; however, it usually develops within the first 2 to 3 months (7,8).

In this study, we aimed to reveal the relevance between the anterior skin crease (ASC) and posterior skin crease (PSC) and DDH and to reveal its value in predicting the presence of DDH. There are controversial studies on this subject.

MATERIAL AND METHOD

The study protocol was approved by Harran University Clinical Research Ethics Board (Project Number: HRU/23.19.37), and written informed consent was obtained from all participants before their participation in the study. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Infants were included in our study who presented to the pediatric clinic for the first time between june 2020/ july 2023 and were between 4-12 weeks of age. We recorded information such as age, sex, number of babies, presence of a family history of DDH, type of delivery (cesarean section:C/S, normal vaginal delivery:NVD), breech presentation, limited hip abduction. We recorded ultrasound findings (hip alpha, beta angle, and type of DDH in the classification made according to these angles) performed between 4-12 weeks for DDH. After USG classification, the DDH class (type Ia, Ib, IIa-, IIa+, IIb, IIc, D, IIIa, IIIb, and IV) was recorded. The graphic classification is shown in **Table 1**. Infants younger than 12 weeks were included, and infants with type IIB and above were classified as DDH (5,6). According to the literature, the ideal time for ultrasonography (USG) screening is the 7th week of life. Screening is usually done between 4-12 weeks. They were grouped according to the presence of ASC and PSC and the groups were compared on the basis of the above characteristics.

Table 1: Ultrasonographic hip typing according to the Graf's classification system (5,6)

Type	Description	α angle (o)	β angle (o)
Ia Ib	Mature (normal) hip	≥60	<55 ≥55
IIa	Physiological delay in maturation (<3 months of age)	50-59	55-77
IIb	Pathological delay in maturation (>3 months of age)	50-59	55-77
IIc	At-risk or critical hip	43-49	≤77
D	Hip on the point of dislocation (decentric)	43-49	>77
IIIa	Dislocated type No disturbance in the structure of the cartilaginous acetabular roof	<43	>77
IIIb	Dislocated type Disturbance in the structure of the cartilaginous acetabular roof		
IV	Highly dislocated hip	<43	>77

Statistical Method

Study data were uploaded to the computer environment and analysed using IBM SPSS 22 (IBM Statistical Package for Social Sciences). Descriptive statistics of categorical variables are presented as numbers and percentages. Cross-tabulations were used to compare categorical variables, and the "Pearson chi-square test" and the "Fisher'sExact test" were applied. Descriptive statistics of numerical variables are presented as mean (±) standard deviation for normally distributed variables and median (min-max) for non-normally distributed variables. The normality distribution of numerical variables was assessed using the "Kolmogorov-Smirnov" or "Shapiro-Wilk" tests. When comparing numerical variables with two independent groups, "Mann-Whitney U" tests were used for the variables that were not normally distributed. The accepted statistical significance level was $p < 0.05$.

RESULTS

DDH was found in 34 of 520 patients (6.58%). While 27 (79.4%) of the 34 patients with DDH were female, 10 (20.6%) were male. DDH was found statistically significantly more often in females ($p < 0.001$).

The presence of ASC and/or PSC was found in 6.58% (34/520). The demographic and clinical characteristics of the groups with and without ASC are shown in **Table 2**. Comparing the groups in terms of gender, the percentage of females was significantly higher in the ASC group (65.6% vs 49.3%, p=0.005). There's no statistically significant difference was found between the groups in terms of the age of the babies (in weeks) and the number of children they were. The presence of DDH in the family history of DDH was significantly higher in the group with ASC (23.3% vs 6.7%, p < 0.001). There was no statistically significant difference between groups in type of delivery (C/S and NVD). Breech presentation were more common in the group with ASC (4.4% vs. 0.5%, p=0.001). PSC was more frequent in the group with ASC (32.2% vs. 4.4%, p < 0.001). There was no statistically significant difference between groups in LHA. There was a statistically significant difference between groups in terms of right hip alpha angle (65º vs. 64º, p=0.010). There was no statistically significant difference between the groups in terms of right hip beta angle. There was a statistically significant difference between groups in terms of DDH type in the right hip (p < 0.001). The presence of DDH in the right hip was higher in the ASC group (7.8% vs. 2.6%, p=0.023). There was a statistically significant difference between the groups regarding the alpha angle of the left hip (64º vs. 62º, p < 0.001). There was no statistically significant difference between the groups regarding the beta angle of the left hip. There was a statistically significant difference between the groups regarding the type of DDH in the left hip (p < 0.001). There was no difference between the groups regarding the presence of DDH in the left hip. There was no difference between the groups regarding the presence of DDH in one hip or the presence of DDH in both hips.

The demographic and clinical characteristics of the groups with and without PSC are shown in **Table 3**. Comparing the groups in terms of gender, the percentage of female was significantly higher in the PSC group (70.8% vs. 50.2%, p=0.006). There's no statistically significant difference was found between the groups in terms of the age of the babies (in weeks) and the number of children they were. The presence of DDH in the family was significantly higher in the group with PSC (35.4% versus 7%, p < 0.001). There was no statistically significant difference between the groups in the type of delivery. Breech presentation were more common in the PSC group (6.3% vs. 0.2%, p=0.012). ASC was found more often in the PSC group (60.4% vs. 12.9%, p < 0.001). There was a statistically significant difference between groups in LHA (p=0.004). There was no statistically significant difference between the groups in terms of alpha and beta angle of the right hip. A statistically significant difference was found between the groups in relation to the type of DDH in the right hip (p < 0.001). The presence of DDH in the right hip was found more frequently in the PSC group (14.6% versus 2.3%, p = 0.001). There was a statistically significant difference between groups in left hip alpha angle (64º vs. 60º, p < 0.001). There was a statistically significant difference between the groups in terms of the beta angle of the left hip (58 º vs. 62º, p=0.042). A statistically significant difference was found between groups in terms of DDH type in the left hip (p < 0.001). The presence of DDH in the left hip was found more frequently in the PSC group (18.8% vs. 4.2%, p=0.001). The presence of DDH in each hip was noted more frequently in the PSC group (20.8% versus 5.1%, p < 0.001). The presence of DDH in both hips was detected more frequently in the PSC group (12.5% versus 1.5%, p<0.001). **Table 4** shows the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for the presence of DDH in patients with ASC, PSC and ASC+PSC groups.

Table 2: Clinical characteristics of patients with and without anterior skin creases

	ASC-negative (n=430)	ASC-positive (n=90)	p
Gender, Female (%)	212/218 (%49.3)	59/31 (%65.6)	0.0051
Age, weeks	7 (4-12)	8 (4-12)	0.5242
Delivery number of baby	2 (1-6)	2 (1-4)	0.7542
Family history, Yes (%)	29/401 (%6.7)	21/69 (%23.3)	<0.0011
Type of delivery, NVD (%)	243/187 (%56.5)	51/39 (%56.7)	0.9781
Breech presentation, Yes (%)	2/428 (0.5%)	4/86 (4.4%)	0.0011
PSC, Yes (%)	19/411 (4.4%)	29/61 (32.2%)	0.0011
LHA, (n%)			
No	398 (92.6%)	80 (88.9%)	
Right	3 (0.7%)	2 (2.2%)	0.3171
Left	6 (1.4%)	3 (3.3%)	
Both hip	23 (5.3%)	5 (5.6%)	
Right alfa angle	65 (32-81)	64 (41-78)	0.0102
Right beta angle	57 (32-80)	59 (39-80)	0.4472
Right hip type			
Ia	184 (42.8%)[a]	32 (35.6%)[a]	
Ib	216 (50.2%)[a]	36 (40%)[a]	
IIa-	9 (2.1%)[a]	6 (6.7%)[b]	
IIa+	10 (2.3%)[a]	9 (10%)[b]	
IIb	3 (0.7%)[a]	1 (1.1%)[a]	<0.0011
IIc	6 (1.4%)[a]	2 (2.2%)[a]	
D	0 (0%)[a]	3 (3.3%)[b]	
IIIa	1 (0.2%)[a]	0 (0%)[a]	
IIIb	0 (0%)[a]	1 (1.1%)[b]	
IV	1 (0.2%)[a]	0 (0%)[a]	
Right DDH, Yes (%)	11/419 (2.6%)	7/83 (7.8%)	0.0233
Left alfa angle	64 (39-80)	62 (32-79)	<0.0012
Left beta angle	58 (33-81)	58.5 (35-80)	0.7952
Left hip type			
Ia	146 (34%)[a]	29 (32.2%)[a]	
Ib	228 (53%)[a]	33 (36.7%)[b]	
IIa-	13 (3%)[a]	10 (11.1%)[b]	
IIa+	22 (5.1%)[a]	10 (11.1%)[b]	
IIb	8 (1.9%)[a]	0 (0%)[a]	<0.0011
IIc	7 (1.6%)[a]	2 (2.2%)[a]	
D	1 (0.2%)[a]	0 (0%)[a]	
IIIa	1 (0.2%)[a]	2 (2.2%)[b]	
IIIb	2 (0.5%)[a]	4 (4.4%)[b]	
IV	2 (0.5%)[a]	0 (0%)[a]	
Left DDH, Yes (%)	21/409 (4.9%)	8/82 (8.9%)	0.1321
DDH, Yes (%)	24/406 (5.6%)	10/80 (11.1%)	0.0541
Both of hip-DDH, Yes (%)	8/422 (1.9%)	5/85 (5.6%)	0.0573

1 Pearson Chi-Square test 2Mann-Whitney U test 3 Fisher's Exact test, NVD: Normal vaginal delivery, C/S: Cesarean section, PSC: Posterior skin creases, LHA: limited hip abduction, DDH:Developmental dysplasia of the hip.

Table 3: Clinical characteristics of patients with and without posterior skin creases

	PSC-negative (n=472)	PSC-positive (n=48)	p
Gender, Female (%)	237/235 (50.2%)	34/14 (70.8%)	0.0061
Age, weeks	7 (4-12)	8 (4-12)	0.3052
Delivery number of baby	2 (1-6)	2 (1-4)	0.5462
Family history, Yes (%)	33/439 (7%)	17/31 (35.4%)	<0.0013
Type of delivery, NVD (%)	270/202 (57.2%)	24/24 (50%)	0.3371
Breech presentation, Yes (%)	3/469 (0.6%)	3/45 (6.3%)	0.0123
ASC, Yes (%)	61/411 (12.9%)	29/19 (60.4%)	<0.0011
LHA, (n%)			
No	439 (93%)[a]	39 (81.3%)[b]	
Right	3 (0.6%)[a]	2 (4.2%)[b]	0.0041
Left	6 (1.3%)[a]	3 (6.3%)[b]	
Both hip	24 (5.1%)[a]	4 (8.3%)[a]	
Right alfa angle	65 (32-81)	65 (41-79)	0.4622
Right beta angle	57 (32-80)	58 (33-79)	0.9422
Right hip type			
Ia	201 (42.6%)[a]	15 (31.3%)[a]	
Ib	233 (49.4%)[a]	19 (39.6%)[a]	
IIa-	13 (2.8%)[a]	2 (4.2%)[a]	
IIa+	14 (3%)[a]	5 (10.4%)[b]	
IIb	3 (0.6%)[a]	1 (2.1%)[a]	<0.0011
IIc	6 (1.3%)[a]	2 (4.2%)[a]	
D	1 (0.2%)[a]	0 (0%)[a]	
IIIa	0 (0%)[a]	3 (6.3%)[b]	
IIIb	0 (0%)[a]	1 (2.1%)[b]	
IV	1 (0.2%)[a]	0 (0%)[a]	
Right DDH, Yes (%)	11/461 (2.3%)	7/41 (14.6%)	0.0013
Left alfa angle	64 (39-80)	60 (32-76)	<0.0012
Left beta angle	58 (33-81)	62 (35-80)	0.0422
Left hip type			
Ia	164 (34.7%)[a]	11 (22.9%)[a]	
Ib	244 (51.7%)[a]	17 (35.4%)[b]	
IIa-	17 (3.6%)[a]	6 (12.5%)[b]	
IIa+	27 (5.7%)[a]	5 (10.4%)[a]	
IIb	7 (1.5%)[a]	1 (2.1%)[a]	<0.0011
IIc	7 (1.5%)[a]	2 (4.2%)[a]	
D	1 (0.2%)[a]	0 (0%)[a]	
IIIa	1 (0.2%)[a]	2(4.2%)[b]	
IIIb	2 (0.4%)[a]	4 (8.3%)[b]	
IV	2 (0.4%)[a]	0 (0%)[a]	
Left DDH, Yes (%)	20/452 (4.2%)	9/39 (18.8%)	0.0013
DDH, Yes (%)	24/448 (5.1%)	10/38 (20.8%)	<0.0013
Both of hip-DDH, Yes (%)	7/465 (1.5%)	6/42 (12.5%)	<0.0013

1 Pearson Chi-Square test 2 Mann-Whitney U test 3 Fisher's Exact test
NVD: Normal vaginal delivery, C/S: Cesarean section, PSC: Posterior skin creases, LHA: limited hip abduction, DDH: Developmental dysplasia of the hip

Table 4: According to skin creases' groupssensitivity, specifity, positive predictivty and negative predictive values for developmental dysplasia of the hip

	ASC	PSC	ASC+PSC
Sensitivity	29.4%	29.4%	26.5%
Specifity	83.5%	92.2%	95.9%
PPV	11.1%	20.8%	31%
NPV	94.4%	94.9%	94.9%

ASC: Anterior skin creases, PSC: Posterior skin creases, PPV: Positive predictive value, NPV: Negative predictive value.

DISCUSSION

In this study, we have shown that the presence of ASC and PSC is associated with the presence of DDH. Although the presence of ASC, PSC, and both had low valuable in predicting DDH (PPV, 11.1%, 20.8%, and 31%, respectively), their absence was found to be very effective in excluding DDH (NPV, 94.4%, 94.9%, and 94.9%, respectively).

We found that the percentage of DDH in our study group was 6.54%, which was higher than the data from Turkey. Yazgan et al. reported the prevalance of DDH as 0.4%, Kural et al. as 0.58%, Köse et al. as 1.2%, Çekiç et al. as 1.6%, and Subaşı et al. as 12.1% (2,4,7,9,10). The reason for the higher incidence of DDH in our study might be that we limited our study group to patients with age of 4-12 weeks. Because DDH is a clinical condition whose diagnosis may change over time, the DDH type is preferred in other studies because the diagnosis of DDH changes over time according to the Graf classification. In addition, our hospital is a hospital that appeals to the entire province of Şanlıurfa, and our DDH rates are above Turkey and the World rates. This situation brought to our mind that it may be due to the fact that traditional methods such as strict swaddling are still widely used in Şanlıurfa province. It was noted that the reason for the high rate of DDH detected in the study conducted by Subaşı et al. may be that the hospital where the study was conducted was the reference hospital in terms of DDH. Similar to the literature and Turkish data, this study also found that female gender predominated in DDH patients.

Ultrasound-based typing, which was defined by Graf and has changed little over the years, and the fact that all infants are screened for DDH by USG in the postnatal period have made it possible to diagnose DDH at an early stage and protect patients from future disease. Although USG is a simple imaging modality, there are still rural areas where it cannot be routinely used. In these cases, a simple physical examination can provide findings that can establish a clinical diagnosis and suspicion of DDH. The presence or absence of skin folds can provide clinicians with an suspicion of DDH. In this study, we investigated the relevance between anterior and posterior skin creases and the presence of DDH and their effectiveness in detecting or excluding DDH.

Pili asymmetry was reported to be 35% in the study by Aytekin et al, 10.9% in the study by Yazgan et al, 10.8% in the study by Kural et al, and 4.4% in the study by Ömeroğlu et al (4,8,9,11). In our study, the prevalance of pili asymmetry was 6.58%. The reason for the high rate in the study by Yazgan et al. might be that it occurs the study population includes just type IIa and above.

In the study conducted by Yazgan et al, the specificity of the presence of pathologic physical examination

findings in predicting the presence of DDH on the USG was reported to be 76%, sensitivity was 60%, PPV was 26%, and NPV was 93% (9). A high NPV value was also obtained in our study. However, in the study by Yazgan et al, foot deformity, torticollis, and LHA were included among the pathological examination findings in addition to skin folds, and the specificity, sensitivity, PPV, and NPV rates for skin folds independently of others were not reported. In the study by Ömeroğlu et al, the specificity and sensitivity of pili asymmetry in relevance to the presence of DDH were reported to be 12.6% and 96%, respectively (8). In the study conducted by Subaşı et al, the asymmetric gluteal skin fold with respect to the presence of DDH have sensitivity 36.8%, specificity 84.8%, PPV 25%, and NPV 90.7%, and the asymmetric inguinal skin fold with respect to the presence of DDH havesensitivity 26.5%, specificity 92.5%, PPV 32.6%, and NPV 90.2% (7). In addition, both findings combined with respect to the presence of DDH havesensitivity 63.3%, specificity 77.3%, PPV 27.7%, and NPV 93.9%. In addition, the sensitivity, specificity, PPV, and NPV of other physical examination findings such as Barlow and Ortolani were analyzed in this study to indicate the presence of DDH. While the sensitivity, specificity, and NPV values of the physical examination findings increased, no increase in the PPV value was demonstrated. NPV values were also found to be high in our study. This indicates that although the presence of these physical examination findings may also occur in normal infants without DDH, the likelihood of DDH is significantly lower in their absence.

In the systematic meta-analysis by Chavoshi et al. that compiled 25 studies evaluating the efficacy of physical examination findings (Ortolani, Barlow, and limited hip abduction) in detecting DDH, clinical findings were found to have high specificity but low sensitivity in detecting DDH; it was commented that their usefulness as a screening test was limited. Also, the authors concluded that if clinical examinations must be used for screening, the combination of Ortolani, Barlow, and LHA tests may provide higher sensitivity than performing these tests independently (12). We also demonstrated that specificity and PPV increased when ASC and PSC were used together compared with using ASC and PSC alone in the study population. However, we were unable to evaluate other physical examination results (Ortolani and Barlow) in our study.

In the study conducted by Touzopoulos et al., unlike other studies, they showed that asymmetrical thigh folds or isolated thigh folds are a false positive sign with low predictive value in the diagnosis of developmental hip dysplasia in infants (13).

Our study has some limitations. Because it was a retrospective cross-sectional study, the prevalance of DDH according to USG classification was uncertain in the follow-up period due to lack of data. Moreover, in addition to skinfolds, other physical examination findings such as Ortolani, Barlow, and Galeazzi were not recorded in our study group. Therefore, in addition to skinfolds, we could not show the DDH predictive value of these findings in the study group by comparing them with skinfolds.

CONCLUSION

This study has shown that skin folds, which are a simple physical examination finding, are important to exclude the diagnosis of DDH but not to diagnose DDH. We believe that the presence or absence of skinfolds in areas where USG examination, which is effective for the diagnosis of DDH, is not available will help the physician in the suspected diagnosis of DDH.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study protocol was approved by Harran University Clinical Research Ethics Board (Project Number: HRU/23.19.37).

Informed Consent: The mothers were first informed about the study and then signed written consent forms.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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