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The Evaluation of The Treatment Outcomes with Pavlik Harness in Developmental Dysplasia of The Hip

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ABSTRACT

Developmental dysplasia of the hip (DDH) is the most common developmental abnormality that affects the hip. The aim of the treatment of DDH is to achieve the anatomical reduction for normal development of femoral head and acetabulum in the soonest possible time and to maintain this reduction. Therefore, Pavlik harness is primarily preferred. In the present study, it was aimed to compare the clinical and radiological results with literatüre in the 0-6 month patients with DDH who were treated using Pavlik harness and also to investigate the effects of the patient variables on treatment outcomes.

82 hips of the 52 patients treated and followed-up by two authors were included in the study. The data from the patient files such as age at diagnosis, ultrasonography (US) type according to the Graf method, treatment duration, the findings of physcial examination, risk factors and presence of avascular necrosis (AVN) were analyzed.

According to the Graf method; 2, 38, 33 and 9 hips were classified as type IIa-, IIb, IIc and III, respectively. Pavlik harness treatment was accepted successful in 72 (87.8%) hips whereas treatment was considered unsuccessful in 10 (12.2%) hips. The rate of type IIb hip was significantly higher in the successful treatment group. The rate of treatment failure was significantly higher in the type III hip. We have concluded that presence of limitation of abduction and Graf type III hip increased the rate of treatment failure in the Pavlik harness treatment of DDH.

Key Words: Developmental dysplasia of the hip, Pavlik harness, Graf type

Introduction

DDH is the most common developmental abnormality that affects the hip (1). The aim of the treatment of DDH is to achieve the anatomical reduction for normal development of femoral head and acetabulum in the soonest possible time and to maintain this reduction. Dynamic or static orthosis that keeps the hip at abduction or flexion is used for treatment of 0-6 month patients with DDH. The application of Pavlik harness as a dynamic method is primarily preferred (2).

Pavlik harness has been introduced in 1946 and become commonly used worldwide in the treatment of DDH thanks to high treatment success and low AVN rates (3,4). Arnold Pavlik has aimed by his treatment method named as "functional treatment" to obtain spontaneous and harmless relocation and centralization of the femoral head by active movement of the hip joint. Pavlik has proposed that his harness allows active movements of the hip by keeping the hips and knees in flexion and the hips in abduction and thus first relaxes the adduction contracture and subsequently will be spontaneously reduced during the abduction movements (5).

In the present study, it was aimed to compare the clinical and radiological results with literature in the 0-6 month patients with DDH who were treated using Pavlik harness and also to investigate the effects of the factors such as US type of DDH according to the Graf method (6), age at treatment onset, limitation of abduction, use of swaddling and family history on treatment outcomes.

Materials and Method

The files of the 0-6 month patients diagnosed with DDH and treated with Pavlik harness in our clinic between the years 2013-2018 were retrospectively screened. The patients with lack of parental compliance to the Pavlik harness treatment were excluded from the study. 82 hips of the 52 patients treated and followed-up by two authors were included in the study.

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Table 1. Patient variables

		Min-Max	Median	Mean.±s.d./n-
Age at treatment onset (week)		6.0 - 20.0	12.0	13.9 ± 4.3
Side	Right			42 51.2%
	Left			40 48.8%
Hip type	IIa-			2 2.4%
	IIb			38 46.3%
	IIc			33 40.2%
	III			9 11.0%
Limitation of abduction	(-)			42 51.2%
	(+)			40 48.8%
Use of swaddling	(-)			17 20.7%
	(+)			65 79.3%
AVN	(-)			82 100.0%
	(+)			0 0.0%
Family history	(-)			58 70.7%
	(+)			24 29.3%
Duration of Pavlik treatment (week)		3.0 - 24.0	12.0	12.5 ± 5.9
Treatment	Failure			10 12.2%
	Successful			72 87.8%

Table 2. The statistical analysis of the correlation between the treatment outcomes with Pavlik harness and patient variables

		Treatment Failure		Successful Treatment		p	
		Mean.±s.d./n-	Median	Mean.±s.d./n-	Median		
Age at treatment onset(week)		12.1 ± 3.5	12.0	14.2 ± 4.3	12.0	0.212	m
Side	Right	5 50.0%		37 51.4%		0.934	X^2
	Left	5 50.0%		35 48.6%			
Hip type	IIa-	0 0.0%		2 2.8%		1.000	X^2
	IIb	0 0.0%		38 52.8%		0.002	X^2
	IIc	5 50.0%		28 38.9%		0.502	X^2
	III	5 50.0%		4 5.6%		0.001	X^2
Limitation of abduction	(-)	1 10.0%		41 56.9%		0.005	X^2
	(+)	9 90.0%		31 43.1%			
Use of swaddling	(-)	3 30.0%		14 19.4%		0.440	X^2
	(+)	7 70.0%		58 80.6%			
AVN	(-)	10 100.0%		72 100.0%		1.000	X^2
	(+)	0 0.0%		0 0.0%			
Family history	(-)	8 80.0%		50 69.4%		0.492	X^2
	(+)	2 20.0%		22 30.6%			

The data from the patient files such as age at diagnosis, US type according to the Graf method, treatment duration, the findings of physcial examination, risk factors and presence of AVN were analyzed. The data we obtained as a result of the study are given in Table 1.

Fig 1. Application of the Pavlik harness and markings on the straps of the harness

After the parents of the patients are informed about DDH and Pavlik harness treatment, especially mothers were trained about application and use of Pavlik harness. Pavlik harness was applied at hip flexion of 90°-100° of flexion and nonrigid abduction (avoiding >30° adduction), anterior and posterior straps were tightened and the buckles were marked (Figure 1). Thereby, confusion of the mother was avoided. The mother was instructed how to carry and hold the baby. Pelvic radiography was obtained after application of the Pavlik harness to obtained the image in which proximal end of the femur pointed Y-shaped cartilage (Figure 2). The patients were dated for weekly control examination to control the proper use of the harness and allowed for weekly bath.

The patients were controlled by US and clinical examination at the third weekly examination. The application of Pavlik harness treatment was terminated in the patients without improvement. The absence of any improvement by US staging or continuous limitation of abduction was defined as treatment failure. The treatment of the patients who revealed improvement was continued with Pavlik harness.

In the follow-up and treatment termination of patients; In addition to the clinical examination, US was used in infants younger than 6 months, whereas pelvic radiography in infants older than 6 months.

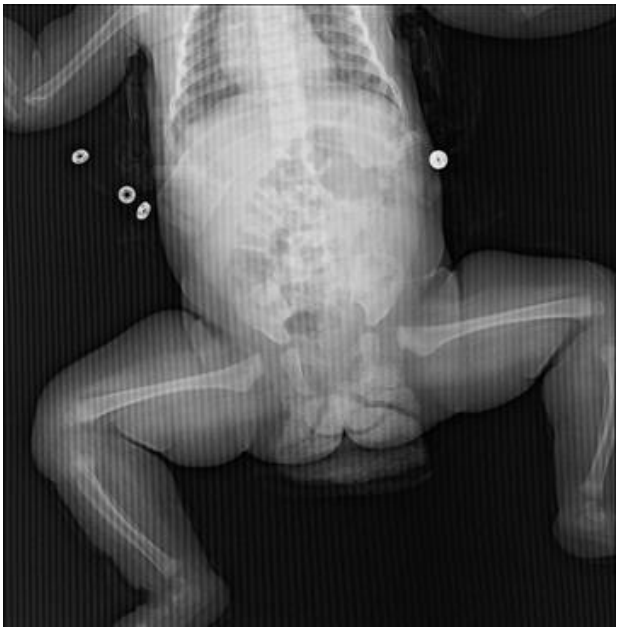

Fig 2. Pelvic radiography after application of the Pavlik harness

The treatment was accepted to be successful if α-angle ≥60° by US or acetabular index ≤30° by anteroposterior (AP) pelvic radiography and hip stability was clinially obtained in the patients. Pavlik harness treatment was terminated in the patients when improvement was achieved according to follow-up outcomes by clinical, US and radiography (Figure 3a,3b).

Statistical Analysis: Statistical Method: Standard deviation, mean, median (lowest and highest values), frequency and percentage values were used in the descriptive statistics of the data. The distribution of the variables were measured by Kolmogorov Smirnov test. The quantitative independent data were analyzed using Mann-Whitney U test. Chi-square test was used in analysis of qualitative independent data while Fisher's exact test was used if use of Chi-Square test is not appropriate. SPSS Software Version 26.0 was used for statistical analysis.

Results

The present study included 82 hips of 52 patients. The patient group was composed of 45 (86.6%) female and 7 (13.4%) male infants. Forty-two right and 40 left hips were analyzed. According to the Graf method; 2, 38, 33 and 9 hips were classified as type IIa-, IIb, IIc and III, respectively. Limitation of abduction, history of swaddling and family history were present in 40, 65 and 24 hips, respectively. Mean age at onset of treatment with Pavlik harness, mean duration of treatment with Pavlik harness and mean follow-up duration treatment with Pavlik harness were 13.9±4.3 (6-20), 12.5±5.9 (3-24) and 27.4±13.1 (7-60) months, respectively.

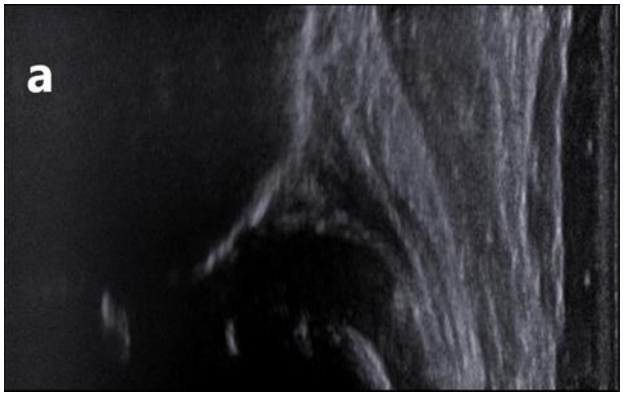

Fig 3a. 3.5 Month female infant, right Graf type III hip

Treatment success with Pavlik harness was achieved in 72 (87.8%) hips, whereas treatment failed in 10 (12.2%) hips. AVN of the femoral head was not found in any of the hips with or without successful.

There was no significant difference between the groups with and without treatment success in terms of age at initiation of treatment, treatment success and Graf IIa and Graf IIc hip types ($p>0.05$). The rate of the Graf IIb hip type was significantly higher in the successful treatment group, whereas the rate of the Graf III hip type was significantly higher in the treatment failure group ($p<0.05$).

The rate of limitation of abduction in the treatment failure group was significantly higher than the successful treatment group ($p<0.05$). There was no significant difference between the groups with and without treatment success in the rate of AVN, family history and swaddling usage ($p>0.05$). The statistical analysis of the correlation between the treatment outcomes with Pavlik harness and patient variables are given in Table 2.

Discussion

The general consensus for the successful treatment of DDH suggests early diagnosis and appropriate treatment method (7). Vierre et al. have reported that infant age at treatment onset for stable hip reduction over 7 weeks, remarkably increased the risk of treatment failure (8). Harding et al. have stated higher rates of treatment failure in the infants over 3 weeks of age at the onset of Pavlik harness treatment compared with those below 3 weeks of age at the onset of Pavlik harness treatment (9). Atalar et al. stated in their study that a higher rate of treatment success was achieved in the treatment of DDH in the infants aged ≤7 weeks of age compared with those over 7 weeks of age (10). On the other side, Kitoh et al. have suggested that they have found no correlation between age at the onset of the treatment and treatment success (11).

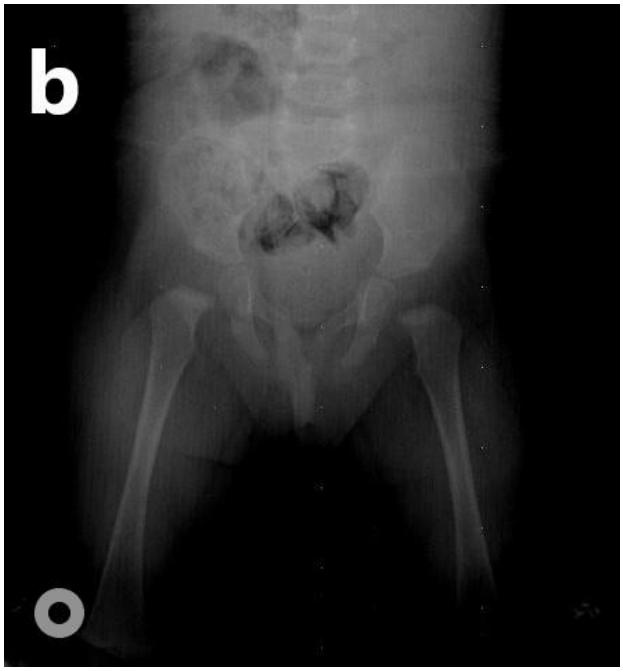

Fig 3b. 9th Month radiography of the same patient

Similarly, Lerman et al. have reported that treatment failure is not related with age at diagnosis and treatment onset of DDH using Pavlik harness (12). We have also determined no relationship between treatment success and age at treatment onset.

Uçar et al. have reported a success rate of 90% in the treatment of Graf type III and Graf type IV hips using Pavlik harness (7). Monster et al. have stated that Pavlik harness treatment was effective in 97% and 50% of the Graf type III and Graf type IV hips, respectively (13). Atalar et al. could have achieved in none of the Graf type IV hips while they have achieved treatment success in only 7 of the 13 Graf type III hips (10). On the other hand, no Graf type IV hip was present in our study while treatment was accepted unsuccessful in 5 of the 9 Graf type III hips.

A treatment success rate of 80-97% has been reported applying Pavlik harness (4,7,12). Total success rate in the present hip types of our patient series was 87.8%

AVN of the femoral head is a complication of treatment of DDH. Excessive positioning, especially extreme abduction, may cause AVN during treatment with Pavlik harness (14).

It has been reported in the previous studies that rates of AVN ranged between 0-33% (1,4,10,14,15). No AVN was detected in our study. We believe that absence of AVN is a result of especially training the mother of the patient about application of Pavlik harness, weekly strict follow-up and application of the harness in the appropriate position (avoiding extreme abduction).

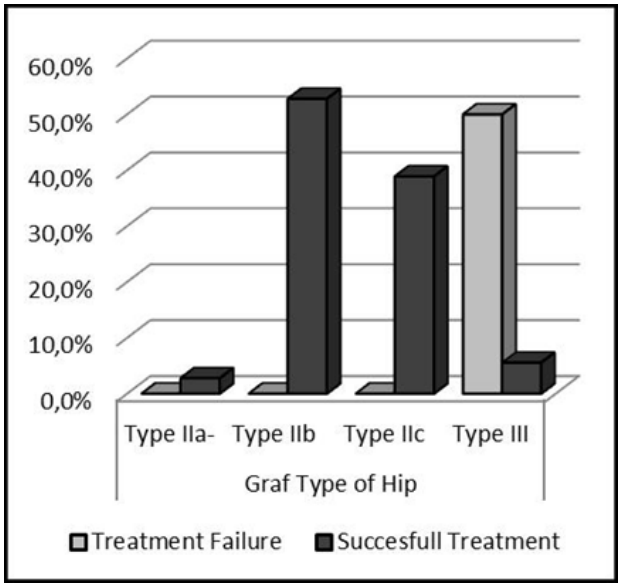

Fig 4. Treatment outcomes according to Graf hip type

The reasons for treatment failure with Pavlik harness include some factors such as lack of parental compliance, limitation of abduction, breech presentation, disclocated hip and delayed treatment onset (8,9,11,16,18). Mubarak et al. have reviewed the reasons of treatment failure in 18 patients treated with Pavlik harness. The reason of treatment failure was unknown in 2 patients whereas the rest of the treatment failures were attributed to application of Pavlik harness in an improper position (at a flexion angle lower than 90°), inadequate follow-up or lack of parental compliance to the treatment (17). The essential components of the successful treatment with Pavlik harness are collaboration and the contribution of the family. Treatment success is very difficult to achieve if family shows noncompliance in the use of Pavlik harness. The patients with lack of parental compliance to the Pavlik harness treatment were excluded from the present study.

Ömeroğlu et al. have reported some reasons for treatment failure such as α angle ≤46°, presence of dislocated hip and the patient age at treatment onset ≥4 months (18). Kitoh et al. have achieved a lower rate of treatment success with Pavlik harness in the infants with hip abduction less than 60° (11). In also our study, the rates of limitation of abduction and dislocated hip were significantly higher in the patient group with treatment failure.

Ömeroğlu et al. have found no correlation between the rate of treatment success with Pavlik harness and patient variables such as family history and use of swaddling (18). In also our study, no significant correlation between the success rate of Pavlik harness treatment and patient variables such as use of swaddling and family history.

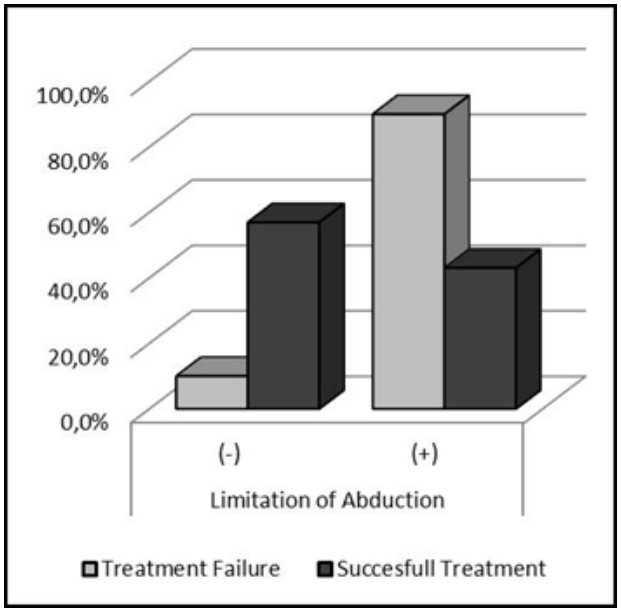

Fig 5. Treatment outcomes according to limitation of abduction

Conclusion

As a consequence, we have concluded that presence of limitation of abduction and Graf type III hip increased the rate of treatment failure in the treatment of developmental dysplasia of hip using Pavlik harness. The parents of such type of patients should be certainly informed about the high risk for treatment failure and secondary treatment. Since there are very few studies in literature on the effect of limitation of abduction on the success of treatment with pavlik harness, there is a need for a larger series of studies on limitation of abduction.

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