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Research Article

Semirigid Abduction Bracing is Effective Treatment of Reducible Developmental Dysplastic Hips after Failure of Pavlik Harness

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Abstract

Developmental dysplasia of the hip [DDH] is a common pediatric condition, treated successfully in 80.2 to 96.7% cases by nonrigid bracing (e.g. Pavlik harness). If treatment fails patients usually undergo closed reduction and hip spica casting under anesthesia. Less invasive therapeutic options are being investigated. This study assessed outcomes of treatment of mild to moderate DDH with semirigid plastic abduction orthosis after initial failure of bracing with Pavlik harness in infants younger than 6 months.

Charts, sonograms and X-rays of 9 patients with 14 hips affected by DDH were retrospectively reviewed. 9 hips were unstable, but reducible, 5 hips were stable; however, remained severely dysplastic at the presentation. All patients were initially placed in Pavlik harness at median age 11 days (3 – 138). All patients were switched to plastic hip abduction orthosis after 30 (21 – 109) days of bracing with Pavlik harness, due to lack of clinical and/or sonographic improvement. After 63 (35 – 124) days spent full time and 245 (64 – 315) days spent part time in semirigid plastic hip abduction orthosis all patients demonstrated full clinical and sonographic recovery after 3 (2 – 5) years of follow up; however, 50% of the hips remained mildly dysplastic radiographically. Minor complications (superficial skin breakdowns at the edges of the brace) were noted in 4 cases.

This study demonstrated that semirigid plastic hip abduction orthosis is a safe and effective treatment option for the infant with developmental dysplasia and a reducible hip, resistant to bracing with a Pavlik harness; however, close monitoring is warranted to address frequent skin complications and residual radiographic dysplasia.

INTRODUCTION

Developmental dysplasia of the hip [DDH] is a common condition of the childhood, affecting 1.6 to 28.5 newborns per 1000 live births [1]. Treatment is age dependent, progressing from abduction splinting with nonrigid or semirigid braces to closed reduction with hip spica cast and finally to open surgical procedures. Pavlik harness is a nonrigid brace widely accepted to treat infants younger than 6 months with DDH in the USA, with 80.2 to 96.7%reported successful reduction and maintenance of reduction rate [2,3]. If the hip is not reduced in 4 weeks,the harness has to be discontinued,and a different form of treatment has to be initiated, e.g. closed reduction under anesthesiaand hip spica casting [3]. The latter is associated with increased incidence of avascular necrosis of the femoral head [AVN] (2.6 to 60%), general risks of anesthesia, higher cost and burden to the family [3,4].

Semirigid bracing of the dysplastic hips with various splints (von Rosen splint, Craig splint, plastic abduction orthosis) has been associated with high success rate (92 to 100%), low incidence of AVN (0.6 to 0.8%) and ease of use for the family [2,5]. In attempt to avoid complications of hip spica casting, there is growing interest in semirigid plastic abduction bracing of the hips in complex situations, such as failure of therapy with Pavlik harness, delayed treatment and residual dysplasia [5-10].

Current literature provides controversial results of treatment of DDH with plastic abduction orthosis after failure of initial

bracing with Pavlik harness in infants younger than 6 months of age [5,7-9]. Hedequist et al reported full resolution of DDH in 13 out of 15 patients with mild to severe DDH(7). Eberle et al presented 13 patients with dislocated dysplastic hips after Pavlik harness splinting, who were successfully treated by plastazote abduction orthosis [5]. Swaroop et al were able to cure 2 out of 3 patients by transitioning them to plastic hip abduction orthosis [9]. In contrast, Ibrahim et al reported 100% failure rate of semirigid abduction bracing in 7 patients with severe DDH [8]. The controversy exists whether effectiveness of bracing with semirigid plastic hip abduction orthosis after failure of Pavlik harness depends on severity of hip dysplasia.

The objective of this study was to determine the outcomes of treatment of mild to moderate DDH with semirigid plastic abduction orthosis after initial failure of nonrigid hip abduction bracing with Pavlik harness in infants younger than 6 months of age.

METHODS

This was a retrospective case series study that included pediatric patients treated by a single surgeon at a pediatricacademic tertiary referral hospital during the period 2000 - 2012. The study was approved by the local Children and Youth Institutional Review Board. The hospital database was screened for specific diagnosis ICD-9 codes from the 754 family: 754.30, 754.31, 754.32, 754.33 and 754.35.

Children 6 month old and younger with unilateral or bilateral developmental dysplastic hips,whofailed initial treatment by Pavlik harness and were subsequently treated by plastic hip abduction orthosis, were included in the study. Children older than 6 months at initial presentation, those with teratologic dislocations or neuromuscular conditions were excluded. Hips were classified according to Hedequist et al at the time of initial examination into stable, no dysplasia; stable, acetabular dysplasia; reduced,dislocatable; dislocated, reducible; or dislocated irreducible [7]. The orthosis was manufactured by a hospital brace shop and was applied in the outpatient clinic settings (Figure 1). Orthosis care instructions were provided to the parents by the medical staff of the clinic. The patients were frequently followed up with weekly ultrasound examinations. The orthosiswas initially worn full time in all cases (23 hours per day with 1 hour break for hygiene); the part time regimen (16 hours per day) was started once clinical and sonographic stability was achieved. Therapy was discontinued once normal radiographic parameters of the hips were recorded on anterior-posterior pelvic X-ray. Clinical and radiographic annual follow up was ensured for the next 2 years minimally.

Both investigators independently reviewed charts, X-rays and sonograms. Age, sex, presentation at birth, laterality, clinical signs of hip stability (Ortolani and Barlow), sonographic parameters such as α-angle and femoral head coverage when treatment with Pavlik harness and plastic hip abduction brace was initiated and terminated were recorded. Time to normalization of ultrasound parameters was calculated and recorded. Sonograms were considered normal if α-angle was equal or exceeded 60 degrees and femoral head was at least 50% covered by the bony acetabulum. X-rays taken at 1 year of age and the end of follow up were screened for residual dysplasia and avascular necrosis of the femoral head. All possible complications related to treatment were also recorded.Descriptive statistics was used to analyze the data.

Figure 1 A photo of the infant placed in a plastic hip abduction orthosis.

RESULTS

9 patients (3 boys and 6 girls) met inclusion criteria. 5 patients were born in breech presentation. Bilateral disease was diagnosed in 5 cases and unilateral – in 4 cases, which rendered 14 hips available for the analysis. Majority of the hips were unstable at the time of the initial examination: among them 5 were dislocated, but reducible, 4 were reduced, but dislocatable. 5 hips were stable; however, remained severely dysplastic. The median age of the patients at the Pavlik harness treatment initiation was 11 days (range 3 – 138). Median duration of treatment in Pavlik harness before switching to plastic hip abduction bracing was 30 days (range 21 – 109). Median duration of full time treatment in plastic hip abduction orthosis was 63 days (range 35 – 124). Median duration of part time treatment in plastic hip abduction orthosis was 245 days (range 64 – 315). Minor complications were encountered in 4 patients (28.6%) - superficial skin breakdowns at the thigh region near the distal edge of the orthosis. All complications were successfully treated with local skin care and short-term discontinuation of the orthosis.

Initial ultrasound examination revealed median α-angle of 46 degrees (range 38 – 58) and median femoral head coverage of 40% (range 0 – 50%). When treatment with plastic hip abduction brace was initiated the median α-angle was found to be 51.5 degrees (range 40 – 56) and median femoral head coverage 37.5 % (range 30 – 50). By the end of treatment all patients had normal ultrasound parameters: α-angle equaled or exceeded 60 degrees, femoral head coverage equaled or exceeded 50%. Median time to normalization of ultrasound parameters after initiation of hip plastic abduction bracing was 117 days (range 21 – 165).

Median duration of follow up was three years (range 2 – 5 years). By the end of follow up all patients had clinically stable hips; however, 50% of the hips remained mildly dysplastic radiographically (Table 1, Figure 2). Median acetabular index at one year of age was 27.5 degrees (range 14 – 34) and at the end of follow up period – 20 degrees [15 – 29].

DISCUSSION

This study demonstrated 100% clinical success rate of the semirigid plastic hip abduction orthosis treatmentof infants younger than 6 months of age diagnosed with reducible hips with developmental dysplasia after initial failure of nonrigid abduction bracing with Pavlik harness. After median 63 days spent full time in the plastic abduction orthosis, followed by median 245 days of part-time bracing, all 9 patients (14 hips) had clinically stable hips with normal sonographic and parameters aftermedian3 years of follow up; however, 50% of the hips demonstrated signs of mild radiographic dysplasia. The latter fact warrants further studies with longer follow up to monitor resolution of dysplasia.

Table 1: Sonographic and radiographic parameters of dysplastic hips during treatment with hip abduction orthosis (HAO).

Patient #	Side	Initial α-angle	α-angle at the start of HAO treatment	Acetabular index at 1 year of age	Acetabular index at the final follow up
1	Left	40	47	17	15
2	Right	46	45	29	29
	Left	51	50	29	27
3	Right	40	40	29	19
	Left	40	40	28	16
4	Right	56	56	28	28
	Left	58	56	26	26
5	Right	55	53	19	15
	Left	38	45	23	15
6	Left	42	55	22	22
7	Right	42	45	34	21
8	Right	55	54	29	17
9	Right	50	55	27	22
	Left	46	54	14	16

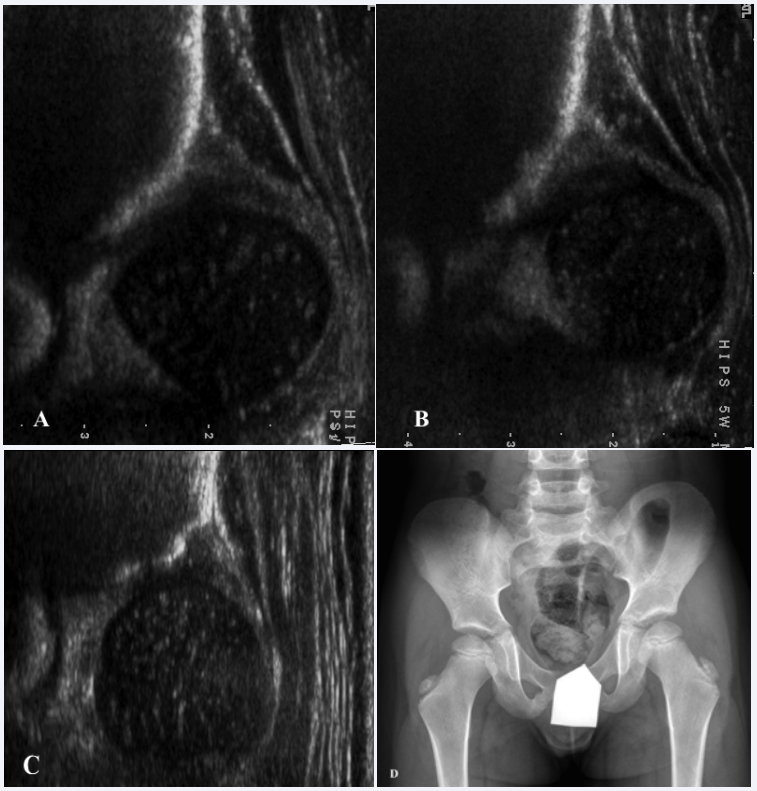

Figure 2 Patient L. – 11 day old male infant, with bilateral developmental dysplasia of the hips (left hip reduced; dislocatable).
A. Ultrasound of the left hip 1 week after application of Pavlik harness consistent with dysplasia (α-angle 45 degrees).
B. Worsening of hip dysplasia after 1 month spent in Pavlik harness (α-angle 38 degrees).
C. Significant sonographic improvement after 3 months of full-time treatment in a plastic hip abduction orthosis (α-angle 65 degrees).
D. Anterior-posterior X-ray of the pelvis after 5 years of follow up demonstrates complete resolution of dysplasia and normal development of both hips (bilateral acetabular indexes equal 15 degrees).

Pavlik harness is a standard of care for the infants diagnosed with DDH at early age; however, it does not lead to recovery in all cases. Treatment of the patients who failed initial nonrigid bracing is a challenging clinical problem due to increased risks, financial and emotional burden associated with current standard therapy with serial hip spica casting [4]. The alternative to closed reduction and spica cast, abduction bracing with a semirigid plastic orthosis, is not supported by a large body of literature yet, andthe studies published to date provide controversial results and conclusions from 87% success to 100% failure rate [2, 5,7,8]. Closer analysis revealed that the populations of the published studies are small and heterogeneous, consisting of the patients with wide range of the severity of hip dysplasia and diversity of orthoses used. Unsurprisingly, the study with bigger proportion of severely dysplastic and dislocated, irreducible hips showed unsatisfactory results with the proposed treatment [8]. Fixation of the irreducible hip in a forcefully abducted and flexed position, provided by the brace, might potentially explain low compliance rate and high incidence of skin breakdown in the study by Ibrahim *et al* [8]. It is also possible that different types of hip abduction orthosis vary in degree of positional control provided especially flexion and external rotation that in turn may affect final results.

The population of this study did not include irreducible hips with developmental dysplasia. All 5 dislocated hips were manually reducible at the presentation. Treatment by the plastic hip abduction brace did not negatively affect children's locomotor development according to Zgoda *et al* [11]. The brace was well tolerated by patients and their families in this study as well. No serious adverse outcomes were encountered; however, 4 patients developed superficial skin breakdowns near the distal edge of the orthosis. Even though the complication was easily controlled by local measures in all cases, close follow up with focused inspection of the skin near to edges of the orthosis is recommended to prevented deep skin necrosis.

All patients in the study group underwent frequent ultrasounds examinations to ensure positive response to therapy. They were switched to part-time bracing once clinical and sonographic stability was achieved. In this study duration of part-time bracing with plastic hip abduction orthosis almost quadrupled compared to duration of full-time bracing. Patients in the landmark study by Hedequist et al also wore the plastic abduction orthosis part-timenearly three times longer than they spent full time in the orthosis [7].

The exact explanation of success of semirigid hip abduction bracing after failure of Pavlik harness treatment has not been clarified yet. Hedequist et al thought that a semirigid hip abduction orthosis provided lesser hip flexion. The latter mechanism was implicated as a potential explanation ofthe failure of Pavlik harnessbracing [7]. It is also possible that a plastic hip abduction orthosis provides more balanced and appropriately rigid fixation of the reduced hip in a safe position of abduction and flexion, reliably centering the femoral head against the acetabulum of the growing child.

Limitations of the study include small cohort, heterogeneous study population and retrospective nature of the study and lack of long term clinical and radiographic follow up.

In conclusion, treatment with a semirigid plastic abduction brace resulted in full clinical and sonographic recovery in all 9 patients /14 hips (100%) with reducible developmentally dysplastic hips, resistant to therapy with Pavlik harness. 4 patients (28.6%) developed superficial skin breakdowns due to rubbing against edges of the orthosis. 7 hips (50%) demonstrated mild radiographic dysplasia at the final short term follow up. Semirigid plastic hip abduction orthosis is a safe and effective treatment option for the infant with developmental dysplasia and a reducible hip, resistant to bracing with a Pavlik harness; however, close monitoring is warranted to address frequent skin complications. Long term clinical and imaging monitoring is advised to ensure complete resolution of residual radiographic dysplasia.

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