

The Use of Pavlik Harness in Developmental Dysplasia of the Hip (DDH): A Local Experience

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ABSTRACT : Out of 46 cases (53 hips) treated with Pavlik harness for developmental dysplasia of the hip in one centre during a six years period, twenty eight children (34 hips) with minimum follow-up of 1 year and an average of 3.5 years were reviewed. Sixty two per cent of the hips presented as dislocated reducible hips, twenty six per cent as dislocated irreducible and twelve per cent as dislocatable hips.

Clinical and ultrasonographic assessment revealed 27 hips, 79 per cent achieved reduction within two weeks of treatment in tailor-made Pavlik harness. On final assessment, 28 hips (82 per cent) had satisfactory concentric reduction. The average duration of harness treatment was 15 weeks. Sex, mode of presentation and presence of associated congenital anomalies and side of involvement did not affect the treating outcome. The age of presentation however affects the result significantly. Those treated before 8 weeksold had 94-100 per cent success rate while after 8 weeks it fell to thirty three per cent. Among the failed cases nearly all of them belong to the clinically dislocated irreducible hip at the first presentation.

INTRODUCTION

In 1990, it has been proposed that the term developmental dysplasia of the hip (DDH) be used in place of congenital dislocation of the hip (CDH) since DDH better describes the spectrum of pathologic changes involved in this clinical condition¹. This new term has now been adopted both by the Pediatric Orthopaedic Society of North America and the European Paediatric Orthopaedic Society. Developmental dysplasia of the hip remains a commonly encountered lower limb problem seen in infancy and early childhood. There is considerable variation in the reported incidence reaching as high as 188.5 per thousand birth among Canadian Indians as

reported by Walker (1973) to as low as zero incidence among African Bantus. Hoaglund, et al. (1981) reported a relatively low 0.1 per thousand incidence among Chinese in Hong Kong. Such differences have been attributed to genetic and environmental factors, the age of the infant at the time of diagnosis as well as on the lack of clear criteria in making the diagnosis of DDH²⁻⁶.

Early treatment of DDH basically consists of achieving and maintaining reduction through the use of splints that hold the hip in flexion and abduction. Of all the retentive device available, Pavlik harness remains to be the most widely used because of its consistent high success rate and the relatively low incidence of complication encountered with its use. First introduced by Pavlik in 1945, it has through the years gained worldwide recognition as an effective functional treatment for DDH.

It employs the principles of active hip flexion and free abduction to achieve gentle, spontaneous reduction of the dislocated hip and maintains the reduction to allow for acetabular development of the dysplastic hip⁷⁻¹⁰.

This study was conducted to review all DDH cases treated with the Pavlik harness at the Prince of Wales Hospital, to obtain demographic and obstetrical data on the infants studied and to identify factors significantly affecting the result of treatment.

MATERIALS AND METHODS

This is a retrospective analysis of Chinese infants treated with the Pavlik harness for DDH from August 1985 to August 1991. Teratological hip dislocations were excluded. Out of the 60 patients identified, 12 were late-diagnosed cases and were excluded from this study as well as 2 cases treated with the Von Rosen splint. A total of 46 DDH cases (53 hips) were treated with the Pavlik harness out of which 28 patients (34 hips) qualified for this study meeting the criteria of having a minimum of 1 year and an average of 3.5 years follow-up (range 1-6 years).

Clinical evaluation was based on hip instability as demonstrated by the Ortolani's and Barlow's tests together

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with supporting evidences of limitation of abduction, asymmetric skin creases and leg length discrepancy. Ultrasonographic evaluation used the Graf criteria classifying hips according to measured alpha and beta angles¹¹. Radiographic observations included acetabular index angle measurement and evaluation for evidences of a vascular necrosis of the capital femoral epiphysis (Kalamchi & MacEwen classification).

On initial presentation, hips were classified into 3 clinical categories. Type 1 (dislocatable) hip, is dislocatable by the Barlow's maneuver but easily reduced after stress was released. Type 2 (dislocated reducible) hip presented with positive Ortolani's and Barlow's tests and a Type 3 (dislocated irreducible) hip was one with fixed dislocation.

The treatment regimen for Pavlik harness is detailed in Fig. 1. The harness was fitted to patients within one week after diagnosis with the hip in 95-100 degrees of flexion and 45-65 degrees of abduction Fig. 1. To prevent extreme abduction which may result in avascular necrosis, parents were instructed to apply small pillows under the thighs of the supine infant thus limiting maximum abduction to 65 degrees. The fit and position of the harness is checked at least twice weekly during the first 4 weeks and every 2-3 weeks thereafter. The achieve-

ment and maintenance of reduction while in the harness was confirmed by ultrasonographic examination for patients less than 6 months of age and by radiographs for older children. After completion of treatment, patients were followed at 6 months interval until after they began to walk and at yearly interval thereafter until skeletal maturity.

The successfully treated group and failed-treatment group were compared statistically (Fisher test) with respect to sex, birth presentation, presence of other associated congenital anomalies, side of involvement including bilaterality, age at initiation of harness treatment and type of hip at initial presentation.

RESULTS

The male:female was 1:3.6. The left hip was the most common side involved (46 per cent) while 32 per cent were right side and 22 per cent were bilateral involvement. The obstetrical data on the infants studied are depicted in Table 1 and the distribution of age at diagnosis in Fig. 2. On initial clinical evaluation, majority (62 per cent) presented as dislocated reducible hips, 26 per cent (9 hips) as dislocated irreducible and 12% (4 hips) as dislocatable hips. Ultrasound evaluation classified 23 hips (68 per cent) as pathological and 11 hips (32 per cent) as normal. The average time spent in the harness was 15 weeks with a range of 11-20 weeks.

Initial clinical evaluation 1-2 weeks after start of treatment revealed a 79 per cent (27 hips) reduction rate with 7 hips (21%) remaining unreduced. Subsequently, 4 other hips achieved reduction later during the treatment period (Fig.3). In 3 hips reduction could not be achieved with the harness within 4 weeks therefore harness treatment was discontinued and a change in treatment modality was instituted (Fig.4). Three hips after achieving concentric reduction while in

Development Dysplasia of Hip (< 6 months of age)

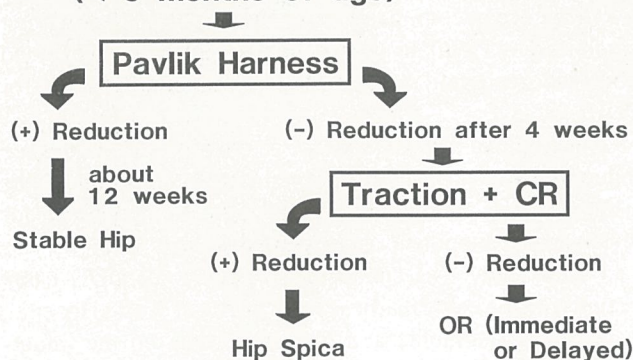


Fig.1 Pavlik harness treatment regimen.

No. of Patients

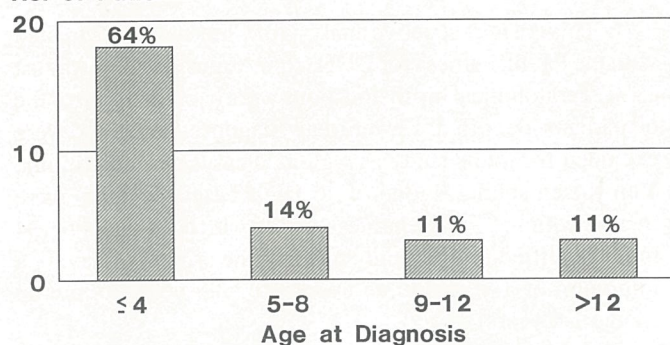


Fig.2 Frequency distribution of age at diagnosis.

TABLE 1
Obstetrical Data on Infants Studied

Breech presentation	64%
Firstborn	75%
Mean BW (kg)	3.5 (2.5-4)
Mean gestational age (weeks)	38 (34-40)
Associated anomalies	29%
Torticollis	(29%)
TEV	(3.5%)

TABLE 2
Results of Pavlik Harness Treatment

Concentric reduction	28 hips	(82%)
No reduction	6 hips	(18%)
Range of motion	FULL	(28 hips)
Avascular necrosis	NONE	

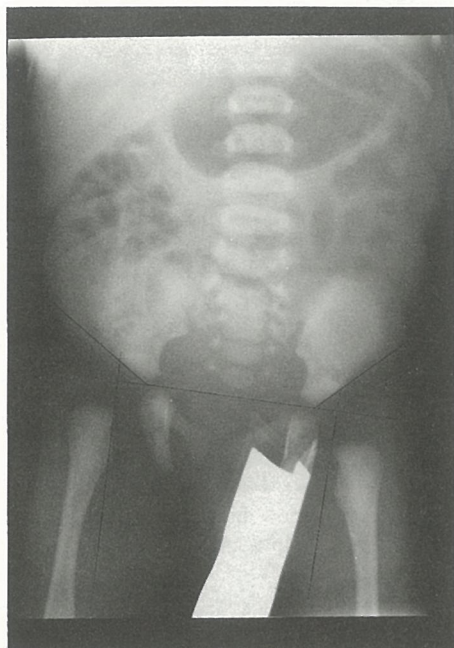
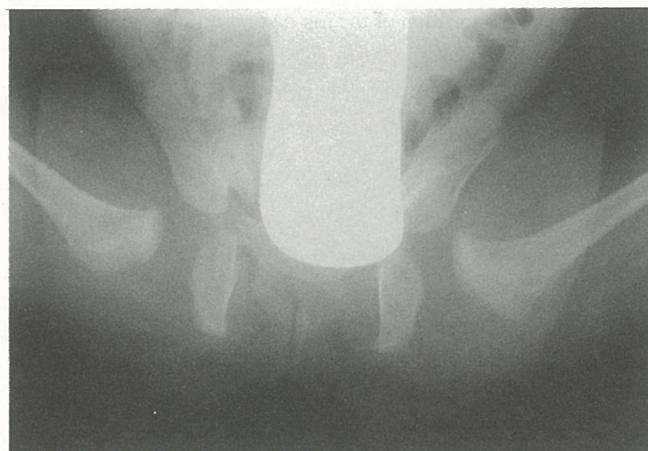
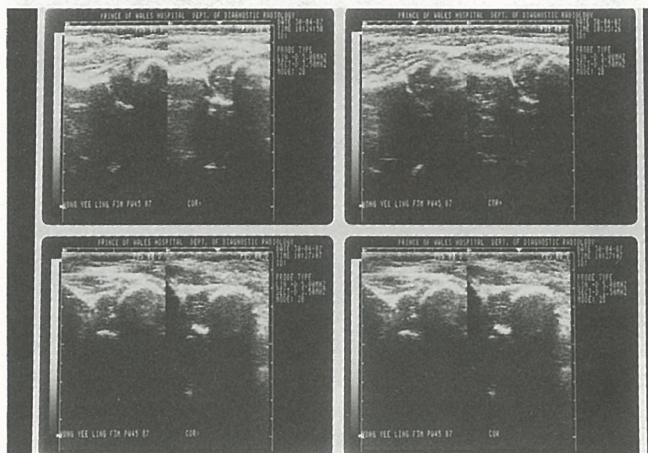


Fig.3 Developmental dysplasia of both hips in a newborn.

(a) Radiogram at day 2 shows both hips to be dislocated. The medial margin of the metaphysis of the femoral neck is lateral to Perkin's line.



(b) Follow-up radiogram while in Pavlik harness shows successful reduction.



(c) Ultrasonograms of both hips taken at 3 months of age show both hips to be reduced with a deep acetabular cup.



(d) Radiogram taken at 5 years of age shows normal development of both hips.

harness failed to stabilize and had redislocation after treatment two of which occurring more than 6 months after harness treatment, corresponding with the time the patients began to walk. Results of treatment on final assessment was summarized in Table 2. The overall success rate of Pavlik harness treatment on final assessment was 82 per cent.

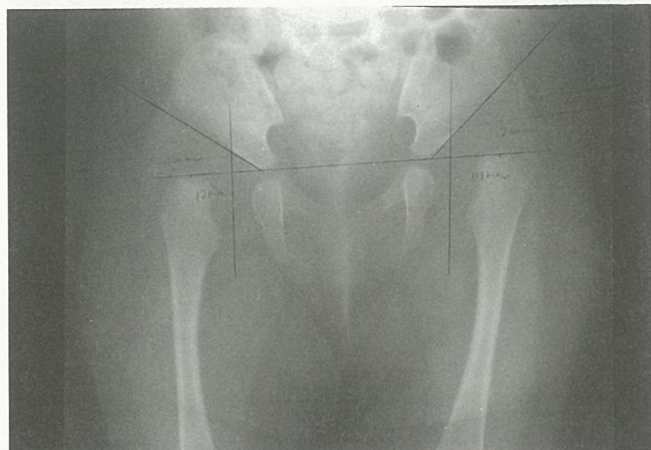
Distribution of success rate by sex, breech presentation and presence of other associated anomalies did not show any significant differences. The side of involvement including bilaterality was also shown not to greatly affect success rate. However, differences in success rate by age at start of treatment proved to be statistically significant ($p=0.007$). An age of more than 8 weeks significantly reduced success rate to 33 per cent compared with 94 per cent success rate of the group

treated within the first month and 100 per cent success rate for those treated at 5 to 8 weeks of age.(Fig.5)

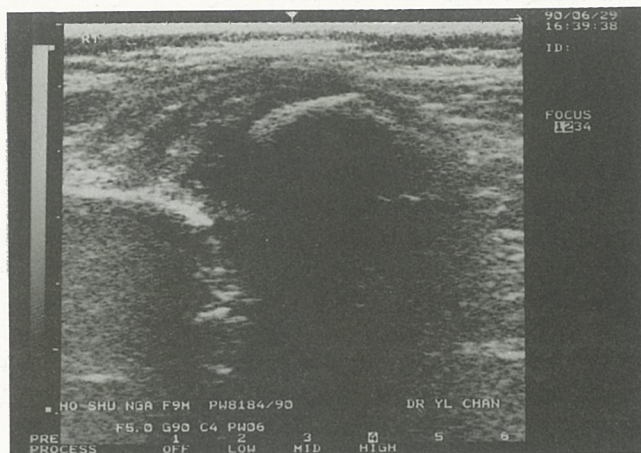
As for hip type on initial presentation, differences in success rates were also statistically significant ($p=0.0148$). All the dislocatable hips and 20 (95 per cent) of the dislocated reducible hips were successfully stabilized. For the dislocated irreducible hips however, the success rate was significantly reduced to 44 per cent (4 hips) (Fig.6).

There were 6 failed cases, majority of which had as age of more than 8 weeks at initiation of treatment (80 per cent) and a dislocated irreducible type of hip (84 per cent). Two of the failed cases underwent preliminary traction followed by closed reduction, three cases had open reduction while another had open reduction and Salter osteotomy.

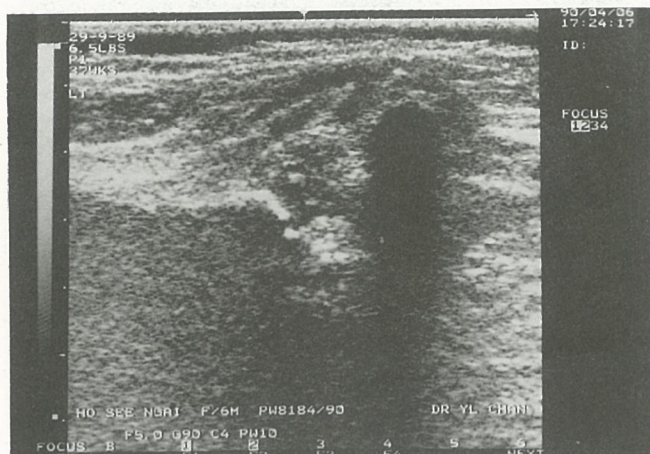
Fig.4 Bilateral dislocation of the hip diagnosed at 5 months of age.



(a) Radiogram shows bilateral dislocation. Clinically, both hips are the dislocated irreducible type.



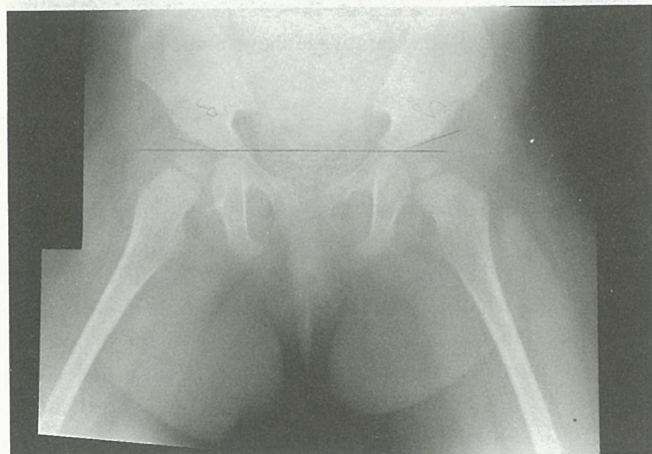
(b) Ultrasonograms of both hips show bilateral dislocation and acetabular dysplasia with decreased alpha angle (Graf Type IV).



(c) Ultrasonograms of both hips show bilateral dislocation and acetabular dysplasia with decreased alpha angle (Graf Type IV).



(d) Radiogram showing failure of reduction with Pavlik harness. The harness was discontinued after 4 weeks when still no reduction was achieved. Patient subsequently underwent bilateral open reduction.



(e) Radiogram at 2 years of age showing maintenance of reduction and hip stability with good acetabular and proximal femoral development.

DISCUSSION

The first 6 months of life represents the ideal time for recognition and therapy of the various manifestations of DDH. Two great efforts should therefore be made to diagnose DDH in the neonatal period thru an effective and efficient neonatal screening program. In this series, majority (64 per cent) were diagnosed within the first month and only 3 cases (11 per cent) were detected at more than 12 weeks of age. Radiographic evaluation of the newborn hip can be deceptive and misleading since much of the newborn pelvis is composed of unossified cartilage and therefore cannot be seen in routine radiographs^{12,13}. Ultra sound provides a more reliable picture of the newborn hip¹¹. We therefore perform ultrasonographic evaluation on all infants with clinical signs of DDH and those at high risk as well.

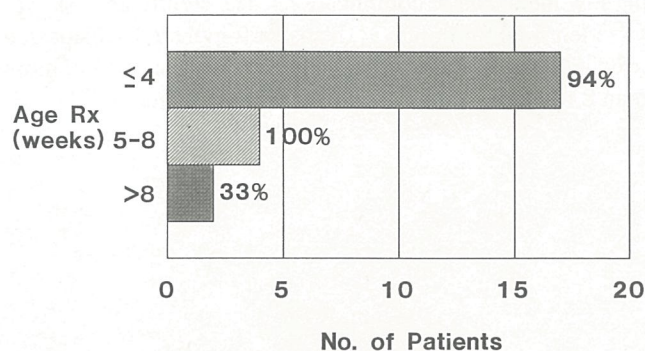


Fig.5 Success rate of Pavlik harness by age at the start of treatment.

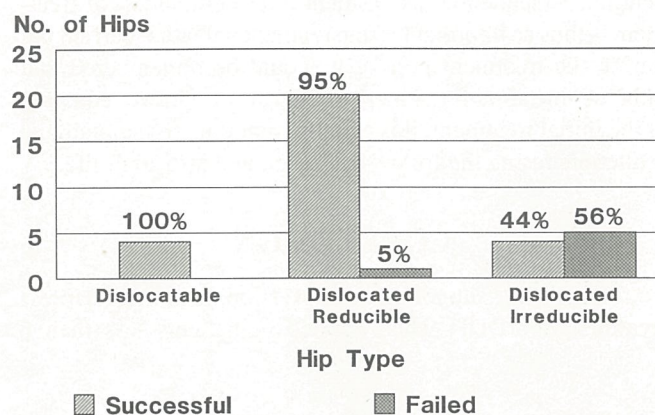


Fig.6 Success rate of Pavlik harness by hip type (clinical).

We prefer to treat all hips showing instability using the Pavlik harness as soon as the diagnosis is made. Much has been said about over diagnosis and over treatment of hip instability but with no reliable measures for predicting which hips will normalize spontaneously and which will have persistent instability, we feel it best to treat all unstable hips with the harness. As much as 20 per cent of untreated unstable hips have been reported to develop subluxation or dislocation. The worldwide acceptance of Pavlik harness treatment for DDH is mainly due to its consistently high success rate and low incidence of complications encountered. To achieve successful treatment, one should ensure provision of good quality harness, complete patient compliance and closed supervision throughout the treatment period⁷. We have obviated the problem of poor acceptance of the harness treatment by the parents by spending more time with parental education.

Ramsey (1976) has reported that majority of children under 6 months of age can be successfully managed with the Pavlik harness on an outpatient basis¹³. We have confirmed this through our own experience with the harness treatment and our success rate of 82 per cent is comparable with previously reported studies. Grill, et al. reported an 86 per cent success rate in a multi center study of 3,611 hips, Pavlik had an 84 per cent success in treating 632 hips while Tsuyama, et al. had a reported rate of 85 per cent for 88 hips treated^{2,8,13}. The two major pitfalls of Pavlik harness treatment include failure

to obtain reduction of the dislocated hip and avascular necrosis of the capital femoral epiphysis⁹. Again, our failure rate of 18 per cent is comparable with that of other published reports. Failure rates of 14 per cent to 19 per cent have occurred in previously reported series^{2,8}.

Avascular necrosis of the capital femoral epiphysis is an unfortunate complication of Pavlik harness treatment (Table 3) with a reported incidence of 0 to 28 per cent^{2,9,14}. In order to minimize if not prevent its occurrence, one should strictly adhere to the proper technique of application and adjustment of the harness. The hip should not be forced into abduction. We try to maintain the hips in no more than 65 degrees of abduction and no more than 100 degrees of flexion at all times. After a follow-up period of 1-6 years (average: 3.5 years) our incidence of avascular necrosis was zero per cent. It should be noted however that our patients have not yet been followed to maturity thus incidence of avascular necrosis for this series may prove to be higher with time. Significant risk factors identified for failure of Pavlik harness treatment in this series included an age of more than 8 weeks at initiation of treatment and a dislocated irreducible type of hip on initial presentation. The presence of risk factors however is by no means a contraindication for harness treatment since there is still a reasonable chance of success even in patients with significant risk for failure. Two (33 per cent) of the patients with age of more than 8 weeks at start of treatment and 4 (44 per cent) of the dislocated irreducible hips were treated successfully with the harness. A trial of Pavlik harness treatment in patients at significant risk for failure is therefore still recommended. These patients though should be followed-up more closely and if no reduction is achieved after 4 weeks then harness treatment should be discontinued and another modality of treatment instituted.

Two patients after initially achieving reduction in the harness had redislocation when they began to walk demonstrating that even after harness treatment hip instability may still persist and manifest only after the child starts weight

TABLE 3
Incidence of Avascular Necrosis

Authors	Year	No. of hips	AVN
Tonnis	1978	4,046	15%
Pavlik	1957	632	2.8%
Grill, et al.	1988	3,611	2.38%
Kalamchi, et al.	1982	325	0%

bearing. A sequential assessment after completion of treatment is thus as important as the regular evaluation carried out during the treatment period. It should be remembered that although the aim of treatment of DDH is to achieve reduction at the initial treatment, it is equally important to maintain the reduction during the follow-up period and into adult life.²

months of age will have a high success rate and a corresponding low incidence of complications. The significant risk factors identified for failure of the harness included a dislocated irreducible type of hip on initial presentation and age of more than 8 weeks at start of treatment with the harness.

CONCLUSION

This study supports the observation that Pavlik harness treatment for DDH when applied in patients less than 6

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