Pitfalls in the Use of the Pavlik Harness for Treatment of Congenital Dysplasia, Subluxation, and Dislocation of the Hip

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Abstract: We reviewed the records of treatment of eighteen infants with congenital dysplasia, subluxation, or dislocation of the hip who had problems with the involved hip following treatment with the Pavlik harness. The most common problem (seen in twelve patients with a dislocated hip) was failure to obtain reduction. This failure was attributed primarily to improper use of the harness by the physician. In some patients, three to five months elapsed before the physician recognized the lack of reduction. In nine patients, a Pavlik harness of poor quality and construction added to both the physician's and the patient's problems, and in six patients, poor patient compliance with the use of the harness was partially responsible for the failure. In three patients who were initially treated in the Pavlik harness, avascular necrosis of the hip subsequently developed, in two following open reduction and in one after closed reduction and cast application.

The physician's indications for use and application of the harness must be appropriate. The child must be examined frequently out of the harness both clinically and roentgenographically. Failure to achieve reduction or adductor relaxation must be recognized promptly and dealt with immediately.

In the twenty-four years since Pavlik first reported its use in 1,912 patients, the Pavlik harness has been used widely as an orthotic device for the management of congenital dislocation of the hip.

When appropriately applied, the harness prevents adduction and extension of the hip while allowing further flexion, abduction, and rotation. This position and motion are designed to aid the gentle, spontaneous reduction of the dislocated hip and acetabular development of the dysplastic hip^{2-4,6}. The purpose of this study was to review the use of the Pavlik harness by physicians in our community and to identify the complications and pitfalls encountered in its use.

MATERIAL AND METHODS

This review is a report of the experience of the orthopaedic surgeons at the University of California at San Diego affiliated hospitals in the use of the Pavlik harness in treating congenital dislocation of the hip. The names of the patients to whom Pavlik harnesses had been prescribed during the period of 1975 through 1979 were obtained from the orthotic agencies in the San Diego area. Additionally names also were obtained from orthopaedic surgeons, clinics, and hospitals who either supplied or constructed their own Pavlik harnesses for distribution to patients.

The records and roentgenograms of 110 patients were reviewed. Eighteen patients with congenital dysplasia, subluxation, or dislocation of the hip in whom problems developed related to the Pavlik harness and its proper use were identified. These patients were divided into two groups based on their ages at the time of diagnosis. In Group I the diagnosis was made in the newborn period. The problem hip was classified as dislocatable or dislocated based on the treating orthopaedist's clinical examination of the patient. In Group II

TAB	LE I
Group-I	Patients

	Age (Mos.)							
Case	At Diagnosis	When Harness Initiated	Diagnosis	Time in Harness (Mos.)	Problem	Reason	Other Treatment	Result
1	Newborn	Newborn	Dislocated, bilat,	3	Failure of reduction, left; femoral- nerve palsy	Orthopaedist: inadequate hip flexion	Traction; open reduction; spica; Pavlik	Reduced; avasc. necrosis
2	Newborn	3	Dislocated, right	3	Failure of reduction	Orthopaedist: inadequate hip flexion; poor parent compliance	Traction; closed reduction; spica; Camp brace	Reduced; avasc, necrosis
3	Newborn	1/4	Dislocatable, left	4	Failure of reduction	Orthopaedist: inadequate hip flexion; poor- quality harness allows adduction; poor parent compliance	Traction; open reduction; spica; Camp brace	Normal
4	Newborn	Newborn	Dislocatable, left	5	Failure of reduction	Orthopaedist: inadequate hip flexion	Traction; open reduction × 2; spica	Normal
5	Newborn	1/2	Dislocatable, right	3	Failure of reduction	Orthopaedist: poor-qual- ity harness allows adduction	Traction; open reduction; spica	Reduced; avasc. necrosis
6	Newborn	Newborn	Dislocated, bilat.	3	Failure of reduction, right	Orthopaedist: no roent- genogram in harness to confirm position	Traction; open reduction; spica	Normal
7	Newborn	1	Dislocatable, right	3	Failure of reduction,	Orthopaedist: inadequate hip flexion; poor- quality harness allows adduction	Traction; open reduction; spica	Normal
8	Newborn	Newborn	Dislocated, left	5	Failure of reduction	Orthopaedist: inadequate hip flexion; poor- quality harness allows adduction	Traction; closed reduction; spica	Normal
9	Newborn	Newborn	Dislocatable, bilat.	3	Failure of reduction, left	Orthopaedist: poor-qual- ity harness allows adduction	Traction; closed reduction; spica	Normal

the diagnosis was made after the age of one month (range, one to ten months). These problem hips were classified as having acetabular dysplasia, subluxation, or dislocation, depending on the appearance of the patient's initial roentgenograms.

The major problems that have been reported to occur with the use of this device for the treatment of congenital dislocation of the hip are failure to achieve a concentric reduction and avascular necrosis^{3-5,7-9}. Other problems that we encountered were delayed acetabular development, failure to stretch the hip adductors, femoral-nerve palsy, and inferior dislocation. The reasons for these problems were determined and classified as being due to:

1. The physician—The physician's indications for the use or application of the harness were inappropriate. In some cases the Pavlik harness used was of poorquality design and allowed inadequate control of hip position.

2. The parents—The parents failed to have the child wear the harness or use it properly.

3. Idiopathic—No physician or parental fault was evident, and other reasons could not be identified.

RESULTS

Eighteen patients were identified as having failures of treatment following use of the Pavlik harness.

Group I

In Group I there were nine patients who were diagnosed as having dislocatable or dislocated hips at birth (Table I). In no instance did the treating orthopaedist's initial recorded examination indicate whether a dislocated hip was reducible or not. Two of the nine patients had bilateral dislocated hips, and one had bilateral dislocatable hips. Following application of the harness, roentgenograms were made for eight of the nine patients. Failure to achieve concentric reduction with the harness was the major problem in all nine patients. One patient (Case 1) also had a transient femoral-nerve palsy.

In six of these patients, the amount of hip flexion obtained in the harness as determined on the roentgenogram never was sufficient to direct the femoral head toward the triradiate cartilage. In five patients a Pavlik harness of poor-quality constructed was used, which allowed adduction and internal rotation of the hip. Futhermore, in all nine patients three to five months passed before the physician recognized that the hip was not reduced. All of these nine patients subsequently required traction, general anesthesia, reduction, and a spica cast. Six of the nine patients eventually required an open reduction. In three patients avascular necrosis subsequently developed, following open reduction in two and after closed reduction in one.

Group II

In Group II, failure to obtain reduction was the problem in four of nine patients for reasons similar to those in Group I (Table II). In Case 17, a ten-month-old boy, attempted reduction of bilateral dislocation failed. This patient did not obtain adequate hip flexion in the harness and was at the upper limit of the age recommended for use of the harness⁴. Furthermore, the six-week trial of spontaneous reduction in the harness was too long. In Case 16, the proper degree of hip flexion first achieved reduction, but excessive flexion then produced an inferior (obturator) dislocation. In three other patients the hip adductors remained contracted. One of these patients (Case 14) was in a poor-quality harness which allowed hip adduction. The other two were in a well made harness that was properly positioned, and no specific reason for the tight hip adductors was found. There were no patients with avascular necrosis in Group II.

Other

Five other patients with instability or dislocation of the hip who had problems with the Pavlik harness were encountered.

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- Case	Age (Mos.)							
	At Diagnosis	When Harness Initiated	Diagnosis	Time in Harness (Mos.)	Problem	Reason	Other Treatment	Result
10	2	2	Dislocated, left	2	Failure of reduction	Orthopaedist: inadequate hip flexion; poor- quality harness allows adduction	Traction; closed reduction; spica; Camp brace; open reduction	Normal
11	11/2	11/2	Dislocated, left	2	Failure of reduction	Orthopaedist: poor- quality harness allows adduction	Camp brace; closed reduction; spica	Normal
12	3	3	Dysplasia, right	5	Failure to stretch adductors after 3 mos.	Idiopathic	Tenotomy; spica; Pavlik	Normal
13	5	5	Dysplasia, left	3	Failure of acetab. development	Orthopaedist: poor- quality harness allows adduction; poor parent compliance	Camp brace	Normal
14	5	5	Subluxated, left	11/2	Failure to stretch adductors after 1½ mos.	Orthopaedist: poor- quality harness allows adduction	Tenotomy; spica	Normal
15	4	4	Dysplasia, left	2	Failure to stretch adductors after 2 mos.; parents refused further treatment	Idiopathic	None	Lost to follow-up
16	6	7	Dislocated, left	4	Inferior dislocation	Orthopaedist: too much hip flexion; improper use	Spica	Lost to follow-up
17	10	10	Dislocated, bilat.	1½	Failure of reduction, bilat.	Orthopaedist: poor indication—child too old; inadequate hip flexion; harness trial too long	Traction; closed reduction; spica	Normal
18	5	5	Dysplasia, right	1	Used for 1 mo.; parents refused further treatment	Poor parent compliance	None	Lost to follow-up

TABLE II Group-II Patients

They were not included in this review because of their diagnoses: myelodysplasia (two), Ehler-Danlos Syndrome (one), teratogenesis (one), and sepsis (one).

DISCUSSION

The construction, application, and use of the Pavlik harness is guided by a few simple principles and practical techniques (Figs. 1-A through 1-D). With commercial production of the Pavlik harness, some of the principles of construction have been violated, which in some cases has resulted in an inadequate harness. A few important points in harness construction must be noted. First, the shoulder straps on the halter (chest-strap) should cross in the back to prevent them from sliding over and down the child's shoulders. Second, the buckles for the anterior (flexor) stirrupstraps should be located at the child's anterior axillary line. If they are placed too far medially, tightening the anterior stirrupstrap will cause not only flexion but also adduction of the hip. Third, the buckles for the posterior (abduction) stirrup-straps should be located over the scapula. Fourth, the Velcro strap for the proximal part of the

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Fig. 1-A: Step A. The chest halter is positioned at the nipple line and fastened with the Velcro[®] closure. The crossed shoulder straps then stablilize the halter at this position.



Fig. 1-B: Step B. The leg and foot are set back into the stirrups and fastened with the Velcro[®] straps. Care must be taken to ensure that the flexor and abduction straps are oriented anteriorly and posteriorly with respect to the child's knee.



Fig. 1-C: Step C. The anterior (flexor) stirrup-straps are connected to the halter. The straps are adjusted so that hip flexion is between 100 and 110 degrees to achieve optimum position of the femoral head relative to the acetabulum. Occasionally, more flexion will be necessary initially to achieve reduction. It is important that the insertion of the anterior stirrupstraps on the halter be at the child's anterior axillary line.



Fig. 1-D: Step D. Lastly, posterior (abduction) stirrup-straps are attached to the halter. The insertion point of these straps on the halter should be located over the child's scapula. The posterior stirrup-straps should be adjusted so that there is approximately five to eight centimeters between the knees when both hips are abducted and the hips have free abduction.

Figs. 1-A through 1-D: Application of the Pavlik Harness 17

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Fig. 2-A. If the Velcro[®] straps are too far distal, the anterior and posterior stirrup-straps will bowstring behind the knee axis. Further tightening of these straps will cause increased knee flexion and relatively poor control of hip position. Abduction and internal rotation of the hip is possible.



Fig. 2-B. With a properly positioned proximal Velcro[®] strap just distal to the popliteal fossa, there is better control of hip flexion and abduction and less flextion of the knee.

leg should be located just below the child's popliteal fossa (Figs. 2-A and 2-B). This strap stabilizes and controls the knee and prevents bowstringing of the anterior and posterior stirrup-straps. With bowstringing of the stirrup-straps, internal rotation and adduction of the hip can occur as the posterior stirrup-strap is tightened (Fig. 3).

The Pavlik harness is indicated in the treatment of hip dysplasia or subluxation in children from birth to about the age of ten months. As the child approaches the age of one year, it usually becomes too difficult to hold the patient in the harness, and a more conventional fixed-position brace will be necessary.

The harness may be used to reduce a congenital dislocation of the hip in a child who is less than eight months old if the criteria of Ramsey et al. are met. They noted that adequate hip flexion must be obtainable so that the femoral head is directed toward the triradiate cartilage, and made a roentgenogram of the hips in flexion prior to application of the harness. The harness is not indicated in patients in whom the dislocated hip is not centered toward the acetabulum in flexion or in infants who

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Fig. 3. This infant is wearing a commercially available Pavlik harness. Note that the insertion points of the anterior (flexor) stirrup-straps are placed medially. Further tightening of these straps will cause not only flexion, but also abduction, of the hips. Also note that the Velcro[®] leg straps are located too far distally. There is bowstringing of both the anterior and the posterior stirrup-straps behind the knee. There is poor knee and hip control for this reason. are more than eight months old with a congenital dislocation of the hip. We have found it more practical to apply the harness on the child and then make the roentgenogram. In disorders such as myelodysplasia (second to fourth lumbar functional level), teratogenic dislocation, and arthrogryposis, either muscle imbalance or stiffness, or both, makes application of the harness nearly impossible. Furthermore, it also usually is inappropriate for use in infants with connectivetissue disorders or as a means of positioning a septic hip after drainage. The generalized capsular laxity found in these conditions may cause inferior dislocation of the hip.

To achieve spontaneous reduction of a congenital dislocation of the hip in an infant who is less than eight months old, the harness is applied and a roentgenogram with the child in the harness is made to confirm adequate flexion (Fig. 4). The harness is worn constantly until hip stability is achieved. The patient is examined clinically, out of the harness, at weekly intervals. By two or three weeks after harness application, both clinical and roentgeno-

		APPLY PAVLIK HARNESS	
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	CL	INICAL FOLLOW-UP WEEK	LY
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	AT 2	2-3 WEEKS CAREFUL CLINIC	CAL
	& ROEN	TGENOGRAM (45°/45° ABDU	CTION)
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REDUCED:	¥	QUESTIONABLE:	NOT REDUCED:
CONTINUE WITH UNTIL NORMAL ROENTGENOGRA	HARNESS EXAM & M	ARTHROGRAM	TRACTION ADDUCTOR TENOTOMY, REDUCTION, ARTHROGRAM, CAST

Fig. 4. Plan of use of the Pavlik harness in the treatment of congenital dislocation of the hip in an infant less than eight months old.

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Fig. 5-A. This child was diagnosed at birth as having bilateral dislocated hips. This roentgenogram, made at the age of three months in the Pavlik harness, demonstrates assymetry of the distance from the femoral metaphysis to the triradiate cartilage. The left hip is abnormal and the Pavlik harness is maintaining the hip dislocated, posterior to the acetabulum. Note that the acetabular margins look quite good because of the outlet-type view of the pelvis when roentgenograms are made with the child in the Pavlik harness. The obturator foramen is visualized poorly and the sciatic notch is well demarcated.



Fig. 5-B. Because of the clinical examination and the ambiguous roentgenogram shown in Fig. 5-A, a second roentgenogram was made with the child out of the harness with the femora in 45 degrees of abduction. This clearly demonstrates the dislocation of the left hip and more accurately demonstrates a true view of the pelvis, showing the acetabular dysplasia which is greater on the left than on the right. This child subsequently underwent a period of skin traction and required an open reduction of the left hip at the age of three months. Subsequently, avascular necrosis developed in the left capital femoral epiphysis.

graphic examination must confirm reduction of the hip. If the hip is not reduced during the three-week trial of harness use, the more conventional approach of traction, general anesthesia, closed reduction, arthrography, and a spica cast should be instituted Fig. 4). As roentgenograms made with the child in the harness are difficult to interpret, we prefer to make a 45-degree abduction (frog-leg lateral) roentgenogram of the hips out of the harness to confirm their position at the three-week visit. Furthermore, evaluation of acetabular development is easier when roentgenograms are made with the child out of the harness. A roentgenogram in the harness produces an outlet view of the pelvis because of the loss of lumbar lordosis and pelvic tilt (Figs. 5-A and 5-B). If the treating physician is still in doubt as to the hip's position, arthrography under general anesthesia should be performed to confirm a concentric reduction (Fig. 4). If the femoral head is in the acetabulum, the patient is followed at two to four-week intervals until the clinical and roentgenographic examinations are normal. Again, these should be performed with the patient out of the harness. Generally, we have weaned a child from the harness according to the plan of Ramsey et at.

The two major problems previously reported with the use of the Pavlik harness are failure to obtain reduction of the dislocated hip and vascular necrosis of the capital femoral epiphysis. Failure to obtain spontaneous reduction of the congenitally dislocated hip with the harness has occurred in 19 per cent of previously reported cases¹⁻⁷. Pavlik reported a failure in reduction of 16 per cent, while others have reported a range of 2 to 92 per cent¹⁻⁷. In the treatment of subluxation and acetabular dysplasia, however, good results have been reported in 98 per cent of the published series^{2,4-6}.

The most common problem was the failure to maintain reduction or to achieve spontaneous reduction of a dislocated hip. The treating orthopaedist did not observe the proper indications for the use of the Pavlik harness, and either applied the harness improperly or used a harness of poor quality construction, or both. The most common error was a failure to obtain enough hip flexion in the harness to achieve reduction (Tables I and II). Moreover, in most cases the orthopaedist failed to recognize the lack of reduction for an average of three and a half months after application of the harness. This delay, more than any other factor, probably accounted for the necessity of open reduction in six of the patients in this series and may be a contributing factor in the cases of avascular necrosis (Figs. 5-A and 5-B).

As noted in the literature, the incidence of avascular necrosis was higher when the harness was used to treat congenital dislocation of the hip rather than subluxation or acetabular dysplasia^{5,8,9}. Pavlik, in treating 632 dislocated hips, reported an incidence of avascular necrosis of 2.8 per cent, although it only occured in hips requiring manual reduction after failure of spontaneous reduction in the harness. Tönnis reported a 15 per cent rate of avascular necrosis in a multicenter study of 4,046 hips9. Others have reported rates of 4 per cent³, 5 per cent7, and 9 per cent10. More recently, Kalamchi et al. have reported no incidence of avascular necrosis with use of the harness in the treatment of seventy-seven dislocated hips, 141 subluxated hips, and 105 hips with acetabular dysplasia.

In this series there were three patients with avascular necrosis (Table I). In these patients the failure of spontaneous reduction in the harness necessitated traction, closed reduction (one patient) or open reduction (two patients), and spica-cast application. Although it is difficult to incriminate any specific procedure, it seems likely that the avascular necrosis resulted from surgical intervention or the cast rather than the harness. However, as noted in the European literature^{8,9}, overly vigorous tightening of the abduction strap may result in avascular necrosis.

Although sufficient hip flexion in the harness to direct the femoral head toward the triradiate cartilage is necessary to achieve spontaneous reduction, excessive flexion may produce problems. In Case 16, first the proper hip flexion achieved reduction and then excessive flexion produced an inferior (obturator) dislocation. Another problem noted with overly vigorous hip flexion was a transient femoralnerve palsy (Case 1). This complication has been reported by others^{4,6}. Hip flexion of more than 120 degrees should be maintained only for the two to three-week trial of spontaneous reduction. If reduction is obtained, the flexion is reduced to 90 to 100 degrees.

In two other patients the hip adductors remained contracted in spite of a well made harness and its proper use (Case 12 and 15). Adductor tenotomy was necessary before acetabular development could proceed. In hip dysplasia, the adductors usually have stretched in one to two weeks after application of the harness. If they remain tight at four to six weeks, percutaneous adductor tenotomy under general anesthesia and possibly an arthrogram may be necessary.

The final problem evident from this series was poor compliance of the parents in maintaining the harness on the child. In two cases (Cases 15 and 18) the parents discontinued use of the harness and refused further treatment. In four patients (Cases 2, 3, 11, and 13), another brace alternative was necessary because of poor acceptance by the parents. Better parental education by the orthopaedist as to the disease process being treated and the use of the harness might have obviated these difficulties.

CONCLUSIONS

The primary difficulty associated with the use of the Pavlik harness in this series was failure to achieve reduction of the dislocation. The orthopaedist must realize that merely applying the harness on the patient with congenital dislocation of the hip does not guarantee reduction of the hip. The important aspects in the use of the harness include: (1) appropriate indications, (2) adequate hip flexion in the harness as verified by roentgenograms, (3) use of a good-quality harness, (4) confirmation of concentric reduction after three weeks of harness use, (5) maintenance of the patient in the harness until a normal clinical and roentgenographic examination is achieved, and (6) education of the parents.

NOTES

¹Dorr, W.M.: Erfahrungen mit dem Riemenbügel nach Pavlik in der Behandlung der sog, angeborenen Hüftgelenksluxation und ihrer Vorstufen. Zeitschr. Orthop., **101**: 535–545, 1966.

²Erlacher, P.J.: Early Treatment of Dysplasia of the Hip. J. Internat. Coll. Surg., 38: 348-354, 1962.

³Fried, Amnon, and Seelenfreund, M.: The Treatment of Congenital Dislocation of the Hip by the Pavlik Strap Brace. Bull. Hosp. Joint Dis., **30**: 153–163, 1969.

⁴Kalamchi, A.; O'Connor, J.; and McEwen, G.D.: Evaluation of the Pavlik Harness in the Treatment of Congenital Dislocation of the Hip. Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Dallas, Texas, Feb. 1978. ⁵Pavlik, Arnold: Die funktionelle Behandlungsmethode mittels

³Pavlik, Arnold: Die funktionelle Behandlungsmethode mittels Riemenbügel als Prinzip der konservativen Therapie bei angeborenen Hüftgelenksverrenkungen der Sauglinge. Zeitschr. Orthop., **89:** 341– 352, 1957.

*Ramsey, P.; Lasser, Stephen; and MacEwen, G.D.: Congenital Dislocation of the Hip. Use of the Pavlik Harness in the Child during the First Six Months of Life. J. Bone and Joint Surg., 58-A: 1000–1004, Oct. 1976.

'Suzuki, R.: Some Complications of Pavlik Method for the Treatment of CDH. In Proceedings of the Fourteenth World Congress of the Société Internationale de Chirurgie Orthopédique et de Traumatologie, p. 100. Japan, 1978.

Tönnis, D.: An Evaluation of Conservative and Operative Methods in the Treatment of Congenital Hip Dislocation. Clin. Orthop., 119: 76-88, 1976.

*Tönnis, D.: Investigation on the Cause of Frequency of Avascular Necrosis in Different Closed Reductions, Primary and Secondary Open Reductions of CDH. In Proceedings of the Fourteenth World Congress of the Société Internationale de Chirurgie Orthopédique et de Traumatologie, p. 107. Japan, 1978. "O'Ueno, R.; Funauchi, Japan, 1978.

¹⁰Ueno, R.; Funauchi, M.; Kura, K.; Tamai, A.; and Nagatsuru, Y.: Die Behandlung der angeborenen Hüftgelenksluxation durch die Pavlik-Bandage. Zeitschr. Orthop., 113: 1090–1095, 1975.

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