

Treatment of congenital subluxation and dislocation of the hip by knee splint harness

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Abstract

The results are reported from a study of 103 cases fitted with the knee splint harness (KSH) which is an orthotic device used for the treatment of congenital subluxation and dislocation of the hip. The knee splint harness consists of a harness attached to posterior plastic shells at the knee which prevent flexion beyond 90 degrees while permitting full and free knee extension. No case was encountered in a 10 year period which failed to reduce. In cases of hip subluxation, reduction was obtained within an average of 5.8 days. In cases of dislocation, reduction was obtained in 6.7 days on average. Follow-up roentgenograms, established that there were no cases presenting with any sign of ischaemia of the epiphysis.

Introduction

Congenital dislocation of the hip has been discussed among Japanese orthopaedic surgeons for many years, being one of the most commonly encountered conditions in Japan. The Lorenz method was introduced into Japan in 1920 and since then has proved a most reliable treatment method. It was considered that aseptic necrosis of the femoral head resulted from the rigid fixation of the hip in frog type plaster casts. The splint described by Von Rosen (1956) which was applied to infants below 2 months old was difficult for the parents to handle. The Pavlik (1957) harness has been

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commonly used in Japan since introduced in 1957. In Japan, this harness design has been modified by different manufacturers. Some of these are however considered to be inadequate, especially those where the longitudinal straps are attached at the incorrect location at the knee which may cause knee contracture. The author has used the Pavlik harness since 1966 and occasionally reduction has been unsuccessful and contracture of the knee encountered. In these cases, the harness has been removed for a period of time and then reapplied with a successful result achieved in most cases. Reduction was most easily achieved in those cases where in addition to the harness a posterior knee splint (KS) was fitted to the affected side (series 1 – 20 cases). In this article we also report upon our experience in the use of the knee splint harness (KSH) (Fig. 1) and the treatment results obtained (series 2 – 83 cases).

Materials and Methods

One hundred and three cases were examined and treated at the department of Orthopaedic Surgery, Kure National Hospital and Fukushima Orthopaedic Clinic over the past 10 years.

Series 1: Pavlik harness was applied coupled with a posterior knee splint (KS) to prevent more than 90 degrees of flexion of the knee (Fig. 2). The splint was applied at the same time as the Pavlik harness or subsequently when reduction was not achieved after a period of 3 weeks.

Series 2: Knee splint harness (KSH) was applied to 30 cases of subluxation and 53 cases of dislocation.

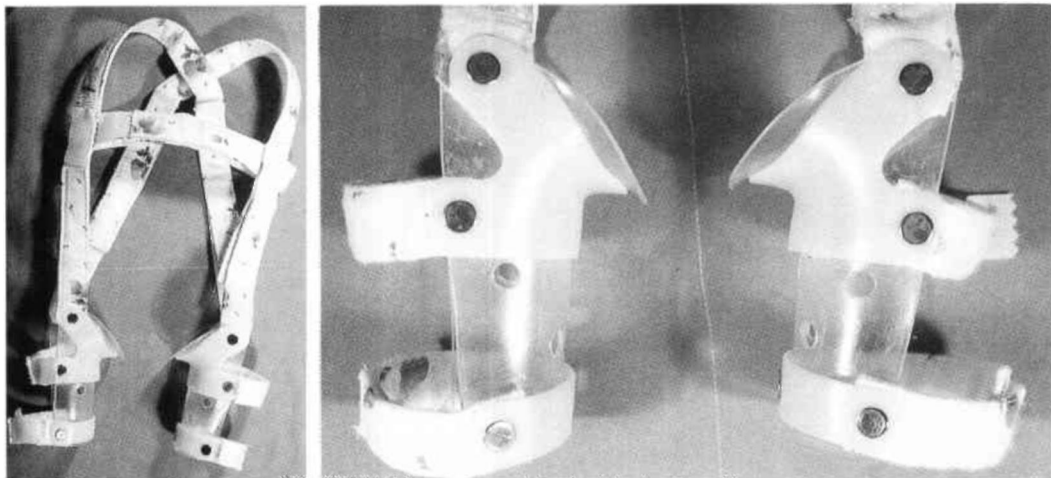


Fig 1. Knee splint harness (KSH) (left). The knee splint is composed of posterior plastic shells with circumferential retaining cuffs (right).

Methods

At the initial patient visit, the hips were examined by the following method. The left hip was held by the thumb and index fingers of the left hand and the knee joint held in 90 degrees of flexion by the right hand of the examiner. With the hip joint in a position of horizontal adduction, the femoral head was palpated posteriorly and with the hip joint in a position of horizontal abduction, the head was then palpated anteriorly. Compressive force was applied to the femoral head posteriorly to determine mobility of the head and check joint stability. The right hip was examined in a similar manner.

The classification of acetabular dysplasia and



Fig 2. Pavlik harness with knee splint (KS) are applied to the left knee joint. The right knee is flexed at more than 90 degrees and the longitudinal strap is displaced posterior to the axis of the knee. The left knee is flexed at less than 90 degrees and the longitudinal strap is located over the axis of the knee.

dislocation according to Dunn (1976) is as follows:

Grade 1: Acetabular dysplasia is minimal or zero, the femoral head is slightly subluxed by application of compressive force (subluxation of the hip).

Grade 2: Dysplasia is moderate, the femoral head is displaced slightly or moderately as observed roentgenographically.

Grade 3: Dysplasia is severe, the superior border of the femoral head is located above the level of the acetabulum as observed roentgenographically.

The KS is a plastic splint comprising posterior thigh and calf sections angled at 90 degrees at the knee joint (Fig. 2). The KSH is a combination of harness and splint. The harness is designed to permit knee flexion from 0 to 90 degrees and hip flexion from 90 degrees to the maximum.

Results

Series 1

Nine cases (7 female, 2 male) were treated by Pavlik harness coupled with KS. Reduction was obtained in all cases in 2 to 14 days (averaging 6 days).

Eleven cases were treated initially with the Pavlik harness above, but in 6 of these cases reduction was not obtained after 3 to 12 weeks of treatment. Following the addition of the KS to the harness, reduction was achieved in all 6 cases within 3 weeks (averaging 8.8 days).

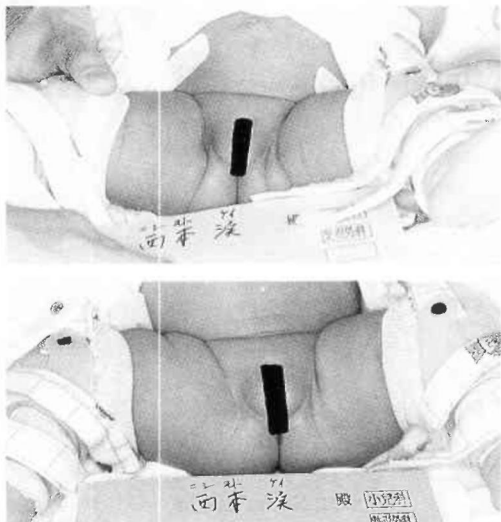


Fig 3. N.K. a one month old female. KSH applied on 16 December 1988. The left hip was adducted immediately after application (top). The adduction contracture at the left hip was corrected within 3 days (bottom).

Series 2

Subluxation of the hip (Grade 1)

Thirty cases were analysed. The sex ratio of female to male was 15 to 15. The age ranged from 2 to 6 months at the time of application (average 3.7 months.) The incidence was 12 right, 17 left and one bilateral. Grade 1 acetabular dysplasia was found in 27 cases with 3 cases of normal development. Reduction was achieved 1 to 17 days after application (average 5.8 days). The period of application ranged from 3 to 15 weeks (average 6.1 weeks). The acetabular dysplasia disappeared between 3 months and 9 months after birth, (average 5.8 months) (Fig. 3).

The period of follow-up ranged from 2 to 57

Table 1. Subluxation of the hip

Cases	30
Sex	female - 15, male - 15
Side	R - 12, L - 17, bil. - 1
Age	2 - 6 months, ave. - 3.7
Grade	Gr. 1 - 22, Gr. 2 - 5
Dysplasia	27 - present, 3 - absent
Reduction	3 - 17 days, ave. 5.8
Application	3 - 15 weeks, ave. 6.1
Disap. of dysplasia	3 - 9 months, ave. 5.8
Follow-up	2 - 57 months, ave. 11.6
Result	normal - 28 acetabular dysplasia - 1 small epiphysis - 1

months (average 11.6 months). The final roentgenograms revealed normal development in 28 hips, acetabular dysplasia in one hip and one hip with a smaller epiphysis than in the unaffected side (Table 1).

Dislocation of the hip

Fifty-three cases were analysed in this study. The sex ratio was 39 female to 14 male. Incidence was 17 right, 35 left and one bilateral. Age at application ranged from one to 6 months, (average 2.5 months). The grades of dysplasia and dislocation according to Dunn's classification were 8 Grade 1, 11 Grade 2, 34 Grade 3. Reduction was achieved one to 39 days after application (average 6.7 days). The period of application was 4 to 18 weeks (average 8.0 weeks). Acetabular dysplasia disappeared at 3 to 9 months after birth (average 5.9 months). Follow-up was at 4 to 60 months (average 13.6 months). Final roentgenograms revealed normal development in 44 cases, smaller epiphysis than in the unaffected hip in 2 cases, acetabular dysplasia in 2 cases and lateralization of the head in 2 cases. Those cases with abnormal findings are expected to become normal (Table 2).

Representative case presentation

Series 1

Case 1: M.Y. a 3 months old female. At first visit, Grade 3 dislocation was noted in left hip and a Pavlik harness applied on 14 November, 1983. Reduction was not obtained, and adductor contracture was not improved until 4 January, 1984. The posterior KS was applied after 51 days of harness wear. Reduction was thereafter obtained in 7 days and the KS was worn for a

Table 2. Dislocation of the hip

Cases	53
Sex	female - 39, male - 14
Side	R - 17, L - 35, bil. - 1
Age	1 - 6 months, ave. - 2.52
Grade	Gr. 1 - 8, Gr. 2 - 11, Gr. 3 - 34
Reduction	1 - 39 days, ave. 6.7 days
Application	4 - 18 weeks, ave. 8 wks
Disap. of dysplasia	3 - 9 months, ave. 5.9 months
Follow-up	4 - 60 months, ave. 13.6 months
Result	normal - 44 small epiphysis - 2 acetabular dysplasia - 2 lateralization - 2

total of 14 days. The Pavlik harness was removed on 12 March 1984 and follow-up roentgenogram at 7 years old revealed a normal hip.

Case 2: O.T. a 3 months old female, delivered by Caesarean section. Grade 3 dislocation in left hip. No reduction was obtained after 3 weeks application of the harness. Following application of the KS

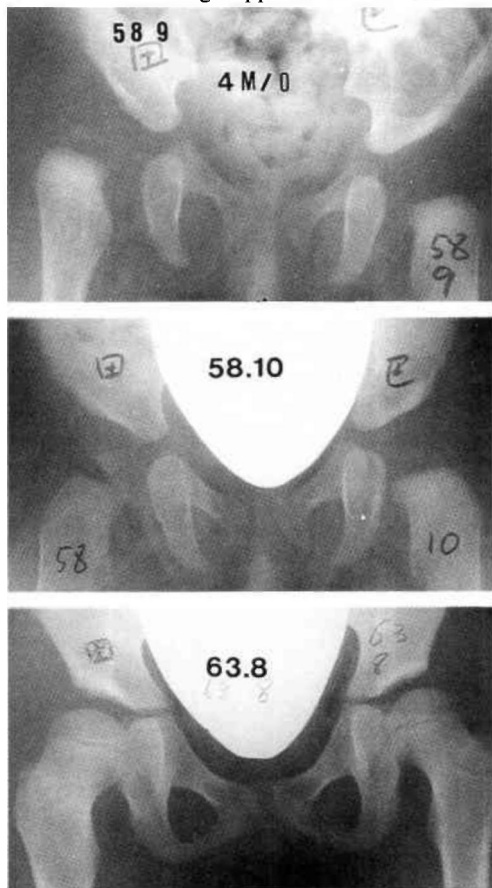


Fig 4. (Top) Series 1 T.T. a 4 month old female diagnosed as Grade 3 dislocation. Pavlik harness was applied on 14 September 1983. Two weeks later reduction was still not obtained. On 27 September, knee splint was applied to the right knee. Three days later, reduction appeared to have been achieved but dislocation still occurred when the hip was adducted. The roentgenogram was taken on 14 September 1983 prior to application of the harness.

(Middle) Stable reduction was accomplished on the 17th day of knee splint application. Pavlik harness had been worn for 4 months and 1 week, the knee splint harness for 2 weeks. The roentgenogram was taken on 21 October, 1983.

(Bottom) The follow-up roentgenogram at the age of 7 years revealed normal hip.

reduction was obtained in 5 days. A roentgenogram at age 12 months revealed an almost normal hip (Fig. 4).

Series 2

Case 3: I.C. a 1 month and 3 weeks old female. At first examination, Ortolani's click sign was evident. Roentgenogram revealed Grade 3 dysplasia and dislocation. The KSH was applied on 27 April 1990. On 2 May, reduction was obtained by abducting the left hip. On 9 May stable reduction was obtained and on 13 June 1990, the KSH was removed. The roentgenogram revealed a round epiphysis and disappearance of acetabular dysplasia.

Case 4: H.A. a 4 months old female. Grade 3 dysplasia and dislocation was noted in left hip on 13 September 1991. A Pavlik harness had been worn for 3 weeks at another clinic without reduction being achieved. One week later this same treatment was repeated unsuccessfully. Arthrography of the hip revealed inverted limbus. At time of first examination in our clinic a Pavlik harness was again fitted and the hip appeared to be reduced in the abducted position but posterior dislocation was induced by adduction. The KSH was applied on 7 February 1992 and stable reduction was obtained in a few days. The KSH was removed on 9 March. On 27 August 1992, the roentgenogram revealed that the epiphysis was round although smaller than that of the right side, and acetabular dysplasia was also improved without lateralization of the head.

Discussion

In 1957, Pavlik reported a harness for the treatment of congenital dislocation of the hip. This was introduced into Japan in the same year. It has been proved by many Japanese orthopaedic surgeons that the incidence of aseptic necrosis of the femoral head can be reduced in frequency by this method. Pavlik stated that femoral head necrosis was due to compressive forces exerted on the head by the action of the adductor muscles with circulatory disturbance in the head as a secondary problem. The mechanism of reduction applied by the Pavlik harness is to keep the hip in more than 90 degrees of flexion with the knee in full extension so that the hamstrings induce the femoral head to locate fully in the acetabulum



Fig. 5 KSH applied with stockinette sleeves. The left hip is flexed with abduction and external rotation and the right hip is extended with adduction and internal rotation.

by the action of the hip extensor mechanism.

We, however, consider that the process of reduction requires that the hip and knee are both kept in 90 degrees of flexion and that the abductive force applied to the hip by the weight of the legs relieves contracture of the adductors, and reduction is thereby induced.

According to Pavlik, the age of application ranged from 2 to 12 months. Takahashi (1985) reported age at the start of initial treatment ranging from 3 to 12 months. The spontaneous reduction rates he achieved were 60% in cases of hip dislocation and 97.9% in subluxation. Twenty-six out of 219 hips required manual reduction and 6 surgical reduction. Aseptic necrosis was observed in 11 joints (6.2%) and lateralization was observed in 21 joints (11.9%). It has been proved in the Series 1 group trial that keeping the knee in 90 degrees flexion or less brings the dislocated hip into reduction. The KSH keeps the hamstrings in tension by blocking knee flexion to more than 90 degrees and blocks hip flexion to less than 90 degrees. Therefore when the hip extends, the hamstrings become tightened and the hip is consequently induced into internal rotation by the strong medial hamstrings which rotate the hip medially. When the hip flexes, it rotates externally because the sartorius and biceps become tightened due to the prevention of more than 90 degrees of knee flexion (Fig. 5). The mechanism of reduction utilised in the early stages is mainly the correction of adduction contracture (Fig. 4). Iwasaki (1983) reported that when the hip was abducted by the harness the adductor muscles were then stretched by the weight of the lower limb. The KSH is more effective in correcting adductor contracture than the Pavlik harness because the former can be

applied at an earlier age and also keeps the hip in abduction. The Pavlik harness tends to hold the hip in a position of more than 90 degrees flexion and the knee in more than 90 degrees flexion. The KSH holds the hip and knee in 90 degrees of flexion so that the adductors are stretched more effectively. The KSH is precisely attached to the transverse axes of the knee so that it permits active knee extension thus preventing the development of knee flexion contractures (Fig. 6). Once the hip is reduced, stability of abduction and adduction, and internal and external rotation are provided by the KSH so that reduction is then maintained by tension of the hamstrings. We have applied the KSH to infants from the age of one month. Stockinette sleeves are used on the limbs to prevent skin problems and infants should also be bathed daily and the skin condition checked by the mother. We have not experienced knee

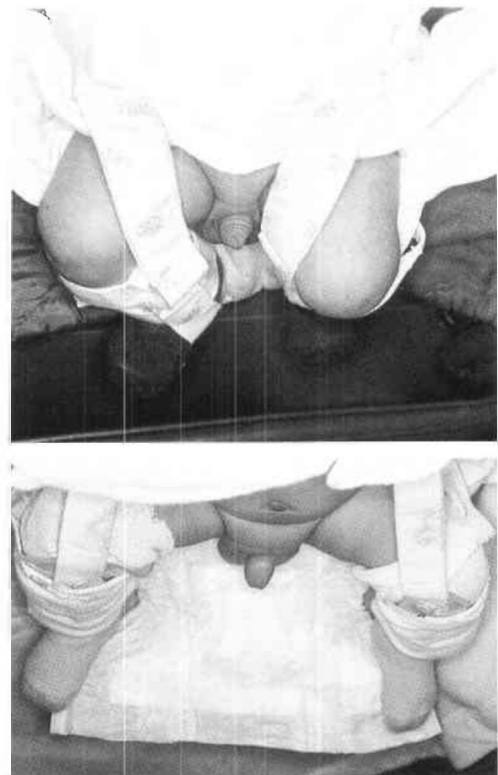


Fig. 6 Comparison between Pavlik harness (top) and KSH (bottom) immediately after application. Hip abduction is greater in KSH than in Pavlik harness in the same patient with left dislocation. The longitudinal straps are located posteriorly to the knee joint in Pavlik harness whereas on the KSH the longitudinal straps are located over the axes of the knee.

flexion contracture problems. Complications with this harness were limited to mild dermatitis during the early phase of this study which was resolved by use of skin cream. Additionally no delayed reduction or aseptic necrosis of the femoral head has been encountered. No other treatment method or surgery has been required in the treatment of all such cases over the past 10 years. Eight cases have now been followed up for a period of more than 3 years, with no evidence of any Perthes-like change found roentgenographically.

Summary

1. The knee splint harness (KSH) has been used for the treatment of 103 cases of hip disorders in children since 1983.
2. Age at time of application was one month and upward.
3. No instances of failed reduction occurred and no other method of treatment was required.
4. Reduction was obtained in all cases in one to 39 days, (average 7 days).
5. The KSH was used for the treatment of unstable hips which were difficult to keep reduced and which were easily dislocated by adduction of the hip.
6. On follow-up, no ischaemic change of the epiphysis was detected roentgenographically.
7. The period of application ranged from 2 to 3 months. When stable reduction was established collectively by dynamic hip examination, symmetrical abduction, loss of adductor contracture and strong extension of the affected hip, KSH should be removed.
8. There have been no complications encountered in the use of KSH except for mild skin rash.

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