R. W. Paton · P. J. Hopgood · K. Eccles

Instability of the neonatal hip: the role of early or late splintage

Received: 18 April 2004 / Accepted: 25 May 2004 / Published online: 12 August 2004
© Springer-Verlag 2004

Abstract From January 1992 to December 1997, 59 dislocatable hips (37 children), confirmed by ultrasound, were splinted by Pavlik bracing within 2 weeks of birth. The majority were splinted within 1 week. From January 1998 to December 1999, 16 dislocatable hips (11 children) were evaluated by ultrasound and were not initially splinted but were followed up by serial ultrasound. They were splinted if they did not spontaneously stabilise on ultrasound. None of those patients treated by immediate splintage between 1992 and 1997 have subsequently required surgical intervention. Two of the infants treated between 1998 and 1999 (12% of the hips) later required a surgical procedure on the hip joint or proximal femur ($p=0.049$, Fisher's exact test). Nine out of 16 hips required splintage at a later date. We would not advocate delayed observation by ultrasound of unstable hips after 2 weeks of age. A clinically unstable hip should be assessed by ultrasound within 2 weeks of birth. If it is unstable on ultrasound, it should be splinted for 6 weeks. There is no need to wean off the splint.

Résumé De janvier 1992 à décembre 1997, 59 hanches luxables (37 enfants), confirmées par ultrasons, ont été immobilisées par un appareil de Pavlik pendant deux semaines après la naissance. La majorité a été immobilisée une semaine. De janvier 1998 à décembre 1999, 16 hanches luxables (11 enfants), ont été évaluées par ultrasons et n'ont pas été immobilisées initialement mais ont été suivies par examens réguliers aux ultrasons. Elles ont été immobilisées si elles n'étaient pas spontanément stabilisées sur l'examen aux ultra-sons. Aucun de ces malades traités par immobilisation immédiate entre 1992–1997 n'a exigé d'intervention chirurgicale. Deux des enfants traités entre 1998–1999 (12% des hanches) ont dû

avoir plus tard un geste chirurgical sur la hanche ou le fémur proximal ($p=0.049$, test de Fischer). Neuf des 16 hanches ont nécessités une immobilisation à une date plus tardive. Nous ne préconisons pas une observation différée par ultrasons des hanches instables après deux semaines d'âge. Une hanche cliniquement instable devrait être étudiée par ultrasons dans les deux semaines après la naissance. En cas d'instabilité aux ultrasons, elle devrait être immobilisée pour six semaines.

Introduction

It has been accepted since the early 1960s that a large number of neonates with dislocatable hips at birth will stabilise spontaneously without treatment [2]. Some authors advocate immediate splintage of all unstable hips with the result that some hips that would otherwise have developed normally are treated unnecessarily. Others advocate a delay in treatment with ultrasound surveillance of the affected hip, treating only those hips that do not stabilise. Over an 8-year period, we prospectively assessed and compared both methods of treatment.

Patients and methods

During the period between 1 January 1992 and 31 December 1999, a prospective ultrasound screening programme for developmental dysplasia of the hip (DDH) was undertaken at Blackburn Royal Infirmary. Using an agreed pro forma, the paediatric department referred all newborn infants with suspected instability of the hip as tested by the Barlow and Ortolani test to the paediatric orthopaedic clinic. At this weekly clinic, all hips were assessed by ultrasound and were examined clinically (Barlow & Ortolani tests) by the senior author (RWP). All infants with clinical suspicion of instability were assessed both clinically and by ultrasound within 2 weeks of birth, the majority being within 1 week.

R. W. Paton · P. J. Hopgood · K. Eccles
Blackburn Royal Infirmary,
Blackburn, UK
e-mail: phil@sugarpit.freemove.co.uk

8 Sugar Pit Lane,
Knutsford, Cheshire, WA16 0NH, UK

Ultrasonography was undertaken using the dynamic method of Clarke, Harcke and McHugh [7] and Harcke [12] and the static morphological alpha angle of Graf [10] and Graf, Tschanner and Klapsch [11]. A Graf angle of over 60° was classified as normal, 43–60° as type II and below 43° as type III. If the hip was dislocatable on stress testing or dislocated (irreducible), it was classified as type IV. In addition, dysplastic hips were classified as subluxed if the head was not centred within the acetabulum [7].

Early splintage group

For the period from January 1992 to December 1997, all cases of instability confirmed by ultrasound at the first paediatric orthopaedic clinic were treated by immediate splintage in a Pavlik harness. These hips were followed up at regular intervals with ultrasound assessment until the hip stabilised and the acetabulum was seen to be developing normally. None of the neonates in this group were weaned off the Pavlik harness.

Late splintage group

During the period from January 1998 to December 1999, all referred cases were not initially treated by splintage but evaluated by serial ultrasounds. Those that did not then spontaneously stabilise ultrasonographically at 2 weeks or did not stabilise on ultrasound at two consecutive orthopaedic paediatric clinics 1 week apart were treated in a Pavlik splint. If the hip stabilised, it was assessed with serial ultrasound. Subluxation or persistent dysplasia were treated with splintage after 8 weeks of age. Again, none of the neonates in this group were weaned off the Pavlik harness.

Results

Early splintage group

During the period from January 1992 to December 1997, 37 patients (59 hips) were referred from the paediatric department with hip instability. Thirty cases of hip instability occurred on the right and 29 cases on the left. Twenty-two cases were bilateral. Mean age at splintage was 6.4 (range 1–14) days, and mean duration of splintage was 6.4 (range 4–12) weeks. Thirty-seven of the 59 hips were splinted when the neonate was under 1 week of age. All of these patients have been followed up to walking age and have normal hips on plain X-ray. None of the patients in this group required surgical intervention or late splintage. There were 2.8 unstable hips per 1,000 live births in this series.

Late splintage group

From January 1998 to December 1999, there were 11 cases of neonatal hip instability (16 hips), referred from the paediatric department with a positive Ortolani/Barlow clinical test (Table 1). Fourteen out of 16 hips were assessed by ultrasound within 1 week of age. Treatment was initiated if there was persistent instability after 2 weeks or after two consecutive orthopaedic paediatric clinics. All hips initially stabilised within 2 weeks; however, five neonates (nine hips) required splintage for progressive subluxation or persistent dysplasia at a mean time of 9.1 (range 7–20) weeks. One hip was unstable at 12 days and was splinted early. This was one hip in a bilateral case, so the other hip was also splinted. There were 2.1 unstable hips per 1,000 births during this series. Five of these 16 hips, were clinically Ortolani positive at birth and at the first paediatric orthopaedic evaluation (within 2 weeks of birth) (Table 1).

All five treated hips required Pavlik splintage. Four were splinted after the age of 6 weeks. One hip was

Table 1 Patients treated with serial ultrasound and delayed splintage (1998–1999)

Number	Age at ultrasound	Alpha right	Alpha left	Unstable side on ultrasound	Age at splintage	Period of splintage	Ortolani positive	Outcome
1	9	45	65	R	—	—	—	
2	6	31	43	L	—	—	—	
3	2	50	56	L	—	—	—	
4	3	47	60	R	8 weeks	6 weeks	—	
5	1	58	52	B	20 weeks	6 weeks	L	
6	4	45	53	B	12 days	6 weeks	L	
7	4	65	65	B	7 weeks	6 weeks	R	Derotation osteotomy (R)
8	5	40	45	B	9 weeks	6 weeks	B	Open reduction (L)
9	5	42	40	B	—	—	—	
10	4	45	53	L	—	—	—	
11	13	62	55	L	—	—	—	

splinted at 12 days, as it was found to be still unstable on the second ultrasound assessment. One of the hips that was clinically Ortolani positive at birth but not at the initial paediatric orthopaedic review appointment (although initially positive on ultrasound) stabilised but later progressively deteriorated. At the age of 2 months, the hip developed significant dysplasia (type III) and limitation of abduction and required splintage. The other six cases (seven hips) that were clinically unstable at birth but clinically stable and ultrasonographically unstable at the first clinic visit developed normally without treatment.

Two of the hips in this series required surgery. Both cases were from the group that had a positive Ortolani test at birth and the first clinic visit. The first case showed persistent dysplasia and, despite splintage, at 16 months of age underwent an arthrogram and derotation femoral osteotomy. The second case initially stabilised within 2 weeks but gradually developed dysplasia/subluxation and progressed to dislocation, subsequently requiring open reduction at the age of 6 months despite Pavlik splintage at the age of 9 weeks. All children in this group were also followed up to walking age.

Correlation between timing of splintage and outcome

The rate of surgery was significantly higher when the neonates were treated with delayed splintage ($p=0.049$, Fisher's exact test).

Discussion

From the time of Barlows original article in 1962, there has been debate about the treatment of hip instability in the newborn [2]. His work showed that 107 out of 119 abnormal hips (90%) stabilised within the first 2 months of life. However, these figures are difficult to interpret, as this group of patients included some who were treated and others who were not. This was a retrospective study that used only clinical tests, which are notoriously unreliable with poor sensitivity. The series is, therefore, too inaccurate by present standards where clinical findings can be confirmed by ultrasound assessment. In 1976, Blockley discussed the management of congenital dislocation of the hip and advised that if the child has a positive Ortolani sign at birth and at 7 days then the hip should be splinted at that stage [3].

The advent of ultrasound scanning has improved our ability to diagnose dysplasia and instability of the hip in the newborn; however, it is questionable whether it has helped resolve the question of when or when not to splint these babies. One of the drawbacks of ultrasound is the over-diagnosis of dysplasia, which then poses the problem of how best to treat these patients with abnormal scans. In 1994, Marks et al. showed that 90% of hips with ultrasound abnormalities would have resolved by 9 weeks [17].

There are currently two schools of thought regarding treatment of neonatal hip instability. The predominant view of mainland Europe is that neonatal hip dysplasia and instability should be treated from birth [8, 20]. The opposing view is that a sizeable proportion of these hips will develop normally and should not, therefore, be treated immediately but instead reviewed regularly by serial ultrasound [1, 6, 19]. Andersson and Funnemark [1] treated 59 dislocatable hips, and in their series, only five required splintage. Castelein followed 101 clinically normal newborn hips that showed varying degrees of dysplasia. They treated none of these patients and simply reviewed them again at 6 months. At follow-up, four had definite dysplasia. They also followed 43 hips with proven instability on ultrasound at an average age of 1.2 days. Again, none of those hips had any form of treatment. At 6 months, none had clinical or ultrasound instability, and all had normal pelvic radiograms. The authors concluded that instability on ultrasound at this early age is a benign finding. Importantly, these hips were clinically stable when first seen by the orthopaedic team [6]. Boeree and Clarke [4] feel that ultrasound screening should be used to assess the degree of displacement of the hip. They suggest that minor sonographic displacement usually resolves. Failure to do so by 6 weeks is an indication to splint. Gardiner and Dunn [9] performed the only controlled trial of immediate splinting versus ultrasound surveillance. The conclusions drawn from their study was that unstable hips can be safely watched for 2 weeks. This time period was chosen in the design of their study and does not mean that a hip that is unstable at 2 weeks has no potential to stabilise. They also concluded that it is probably both safer and less expensive to splint all unstable hips at birth. Proponents of delayed splintage cite the unnecessary exposure of hips that will develop normally to the risk of avascular necrosis [5, 14, 15].

In our initial series, all clinical and ultrasound proven instabilities were treated on diagnosis at the paediatric orthopaedic clinic with a Pavlik harness splintage. The 59 hips developed clinically and were radiologically normal at final follow-up after walking age. The length of splintage was generally 6 weeks, although five cases were splinted for a longer period due to persistent acetabular dysplasia at the 6-week review. None of these patients were weaned off the splint. There were no cases of avascular necrosis in this group.

In the series running from 1998–1999, 14 of the 16 hips initially stabilised, although 9 of the 16 hips later required splintage for persistent dysplasia and/or subluxation. One hip progressed to dislocation despite initially stabilising. This hip developed progressive hip subluxation and a type III dysplasia despite splintage at 9 weeks. Another hip stabilised but developed progressive dysplasia that was treated by splintage at 7 weeks. This did not resolve the dysplasia, and following an arthrogram that confirmed no soft tissue interposition, a derotation femoral osteotomy was undertaken at 16 months of age. The five hips that had a positive Ortolani sign when assessed at the paediatric orthopaedic clinic all required treatment. Although the

hips stabilised ultrasonographically, they all progressively deteriorated, developed dysplasia or subluxation and required splintage and or surgery. There is a possible explanation for the stabilisation and later deterioration in this group with persistent clinical Ortolani signs. Persistent instability of the hip may result in stretching of the capsule and hypertrophy of the ligamentum teres. The hypertrophy of the ligamentum teres may prevent congruous reduction of the femoral head in the acetabulum, inhibiting the normal development of the acetabulum and leading to progressive dysplasia, subluxation or dislocation.

Over the 8 years of this study, there have been no cases of avascular necrosis of the femoral head following splintage. Avascular necrosis is rare with current methods using dynamic splints in the human/safe position of Ramsey [18]. Selective splintage has a risk of surgical intervention or splintage at a later stage. Late splintage is believed to be less successful than early splintage [13, 21]. This has recently been disputed by Lerman et al. who found no difference in outcome in patients splinted either before or after 3 or 7 weeks of age [16].

We would advise that all unstable neonatal hips should be treated by Pavlik splint when confirmed by ultrasound at the paediatric orthopaedic clinic under 2 weeks of age. A larger series would have to be undertaken in order to confirm the true natural history of this condition.

References

- Andersson JE, Funnemark PO (1995) Neonatal hip instability: screening with anterior-dynamic ultrasound method. *J Pediatr Orthop* 15:322–324
- Barlow TG (1962) Early diagnosis and treatment of congenital dislocation of the hip. *J Bone Joint Surg Br* 44:292–301
- Blockley NJ (1976) Treatment of congenital dislocation of the hip. *Children's orthopaedics—practical problems*. Butterworth, London
- Boeree NR, Clarke NMP (1994) Ultrasound imaging and secondary screening for congenital dislocation of the hip. *J Bone Joint Surg Br* 76:525–533
- Bradley J, Wetherill M, Benson MKD (1987) Splintage for congenital dislocation of the hip: is it safe and reliable? *J Bone Joint Surg Br* 69:257–263
- Castlelein RM, Sauter AJ, de Vlieger M, van Linge B (1992) Natural history of ultrasound hip abnormalities in clinically normal newborns. *J Pediatr Orthop* 12:423–427
- Clarke NMP, Harcke HT, McHugh P, Lee MS, Boms PF, MacEwen GD (1985) Real-time ultrasound in the diagnosis of congenital dislocation and dysplasia of the hip. *J Bone Joint Surg Br* 67:406–412
- Ganger R, Grill F, Leodolter S (1990) Ultrasound screening of the hip in newborns: results and experience. *J Pediatr Orthop Br* 1:45–49
- Gardiner HM, Dunn PM (1990) Controlled trial of immediate splintage versus ultrasonographic surveillance in congenitally dislocatable hips. *Lancet* 336:1553–1556
- Graf R (1992) Hip sonography—how reliable? Sector scanning versus linear scanning? Dynamic versus static examination? *Clin Orthop* 281:18–21
- Graf R, Tschanner C, Klapsch W (1993) Progress in prevention of late developmental dislocation of the hip by sonographic newborn hip “screening”: results of a comparative follow-up study. *J Pediatr Orthop* 2:115–121
- Harcke HT (1992) Imaging in congenital dislocation and dysplasia of the hip. *Clin Orthop* 281:22–28
- Harding MGB, Harcke HT, Bowen JR (1997) Management of dislocated hips with Pavlik harness treatment and ultrasound monitoring. *J Pediatr Orthop* 17:189–198
- Kalamchi A, MacEwen GD (1980) Avascular necrosis following treatment of congenital dislocation of the hip. *J Bone Joint Surg Am* 62:876–888
- Langkamer VG, Clarke NMP, Witheroe P (1991) Complications of splintage in congenital dislocation of the hip. *Arch Dis Child* 66:1322–1325
- Lerman JA, Emans JB, Millis MB, Share J, Zurakowski D, Kasser JR (2001) Early failure of Pavlik harness treatment for developmental hip dysplasia: clinical and ultrasound predictors. *J Pediatr Orthop* 21:348–353
- Marks DS, Clegg J, Al-Chalabi AN (1994) Routine ultrasound screening for neonatal hip instability. *J Bone Joint Surg Br* 76:534–538
- Ramsey PL, Lasser S, MacEwen GD (1976) Congenital dislocation of the hip: use of the Pavlik harness in the child during the first six months of life. *J Bone Joint Surg Am* 58:1000–1004
- Terjesen T, Bredland T, Berg V (1989) Ultrasound for hip assessment in the newborn. *J Bone Joint Surg Br* 71:767–773
- Tonnies D, Storch K, Ulbrich H (1990) Results of newborn screening for CDH with and without sonography and correlation of risk factors. *J Pediatr Orthop* 10:145–152
- Viere RG, Birch JG, Herring JA (1990) Use of the Pavlik harness in congenital dislocation of the hip: an analysis of failures of treatment. *J Bone Joint Surg Am* 72:238–244