The effectiveness of a programme for neonatal hip screening over a period of 40 years

A FOLLOW-UP OF THE NEW PLYMOUTH EXPERIENCE

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Since September 1964, neonates born in New Plymouth have undergone clinical examination for instability of the hip in a structured clinical screening programme. Of the 41,563 babies born during this period, 1,639 were diagnosed as having unstable hips and 663 (1.6%) with persisting instability were splinted, five of which failed. Also, three unsplinted hips progressed to congenital dislocation, and there were four late-presenting (walking) cases, giving an overall failure rate of 0.29 per 1,000 live births, with an incidence of late-walking congenital dislocation of the hip of 0.1 per 1,000 live births.

This study confirms that clinical screening for neonatal instability of the hip by experienced orthopaedic examiners significantly reduces the incidence of late-presenting (walking) congenital dislocation of the hip.

Congenital dislocation of the hip (CDH) is a detectable and treatable condition, although debate continues on the optimum method of screening. Clinical examination using the Ortolani1 and Barlow2 tests has been performed on neonates by a range of practitioners, with Leck3 documenting a sensitivity of 66% and specificity of 98% for these methods when compared with the rate of CDH in unscreened European children.

The natural incidence of CDH diagnosed after walking from the pre-screening era was around 1.5 per 1,000 live births4,5 whereas neonatal instability of the hip is more frequent, with Palmén6 in Sweden detecting 6.2 per 1,000 live births. Barlow2 found an early stabilisation rate of 58% for neonatal instability of the hip after one week of life.

Early splintage of neonatal instability, with the goal of reducing late-diagnosed CDH, was implemented successfully in Sweden7 and experienced examiners have produced comparable results.8,9 Since 1990, ultrasound has been used to guide treatment of dysplastic, but not dislocatable, hips in Malmö, Sweden10. The rate of splintage and late diagnosis have decreased concomitantly. The presentation of CDH after the child starts to walk has not, however, been eliminated.

We present our results of 40 years of clinical screening for neonatal hip instability by experienced orthopaedic surgeons, who examine and monitor treatment for all cases. Although the New Plymouth District is relatively isolated geographically, population migration to other areas of the country was considered, and national databases searched to detect any cases of CDH which had presented elsewhere in New Zealand.

Patients and Methods

All babies born in the New Plymouth Maternity Unit between September 1964 and August 2004 were examined within a week of delivery. This unit has specialist obstetricians performing Caesarian sections and a Level 2+ Neonatal Unit with specialist paediatricians and two incubators. The study excluded any neonates requiring immediate transfer to a tertiary referral centre for severe congenital and neonatal disorders; babies with teratological causes of CDH were also excluded.

Orthopaedic surgeons performed twice-weekly examinations at set times in the maternity ward and neonatal intensive care unit. The parents of discharged and home-birth babies were asked to bring them for examination on these days.

Clinical screening was by the Ortolani and Barlow tests and observation of the range of hip abduction. The data for each baby included the National Health Index number, the date of birth, details of abnormal presentation and the findings on examination.1,2 Babies with clinically dislocated or dislocatable hips were treated with the Von Rosen11 splint.

Those with subluxable hips were re-examined at the next clinic, three to four days later, and splinted if the instability persisted.
The splint was used for eight weeks and radiographs of the hip were taken at the age of six months. A final review, after walking was after 18 months and the infant was then discharged.

Neonates whose hip instability was considered to have resolved by the time of re-examination were placed in double nappies and underwent radiological examination at six months. If this and the clinical examination were normal, the infant was discharged.

Late diagnoses were those made in infants who, after a normal neonatal re-examination and double nappy treatment, had CDH diagnosed on the six-month radiograph. Along with failures of splintage and those presenting on walking, they were treated by local orthopaedic surgeons until the last decade of the study, when a specialist paediatric orthopaedic surgeon became available.

The verification of CDH cases requiring operative intervention was undertaken by means of a national postal survey of orthopaedic surgeons, requesting details of any cases of CDH or acetabular dysplasia in patients born in New Plymouth who required operation. Furthermore, a computerised search of the New Plymouth Health Information Service was undertaken for cases of CDH using ICD-9 codes, which have been documented on a national database since 1988. Details of those patients who had required an arthroplasty, adductor tenotomy, closed reduction or open procedure of the hip, pelvis or femur were collected through to December 2006, 28 months after the study period closed in December 2006.

The National Births Registry was then searched, and correlation made between patients requiring operation for CDH and their place of birth.

Results
There were 41 563 live births during the 40-year study period. Of these, 1639 neonates were diagnosed with unstable hips, of which 633 were splinted (1.6%, 16 per 1000 live births).

In an earlier study at 21 years from this unit, Hadlow reported two babies requiring prolonged splintage in hip spicas following a six-week period in a Von Rosen splint. Another was splinted in the unreduced position and required surgery. These three cases were regarded as failures of splintage. There have since been two further failures of splintage, both requiring open reduction. Therefore, over the 40-year study the Von Rosen splintage protocol failed in five neonates.

Two neonates with unstable hips on initial examination who were considered to have stabilised by the second check, and treated in double nappies, presented with radiological evidence of dislocation at clinic follow-up. A third, diagnosed with a dislocated hip at 24 hours, was transferred to a tertiary referral centre where the splint was removed, presented at 11 months of age with the hip dislocated. These three cases are regarded as late diagnoses, but not as late-presenting (walking) CDH and all required further intervention.

Over the 40 years there were four children who presented late on walking. All required surgery. Therefore, the overall failure rate of the clinical screening programme was 12 of 41 563 babies (0.029%; 0.29 per 1000 live births and those presenting on walking was 0.10 per 1000 live births. Assuming 1.5 per 1000 live births as the incidence presenting on walking in an unscreened population, 62 cases would have been expected to require treatment in the 40 years of screening. This indicates that the programme has reduced this level by 93%. When all failures are included, the reduction in CDH requiring treatment is 81%.

There was an 85% response rate to the survey. Neither the survey nor the search of the New Plymouth Health Index and National Births Registry found any cases of CDH requiring treatment outside New Plymouth, other than those discussed above.

In the 20-year period 1984 to 2004 (20 906 births), 589 neonates (2.8%) failed to attend for screening for a variety of reasons. All the 12 failures discussed above were clinically screened for neonatal instability of the hip.

Table I shows little variation in splintage rates over the 40 years, but the numbers of unsplinted neonates, observed in double nappies and reviewed at six months, showed an upward trend. One case of avascular necrosis (AVN), which recovered spontaneously, was described in the first ten years. One baby who failed splintage also developed a full-thickness skin ulcer on the posterior thigh from the splint. This was dressed regularly and the splint padded. The ulcer healed without affecting the treatment.

Discussion
A successful screening programme needs to be directed at a recognised condition whose natural history is understood, and for which there is an agreed, accepted and effective treatment that favourably influences the outcome. The reported failure rates of screening programmes for neonatal instability of the hip vary widely and are influenced by the outcome measured, with walking CDH rates generally lower than failure rates, which include splintage failures (Table II). The results from our study show a similar pattern, with the walking CDH rate of 0.1 per 1000 live births being lower than the overall failure rate of 0.29 per 1000 live births when splintage failures are included. Nevertheless, these figures compare favourably with others reported. An important reason for the success of the New Plymouth neonatal instability of the hip screening program is the continuity of the service, which is well established, widely known, and supported by the local maternity and paediatric services. Also, as the examinations are performed by the same group of experienced orthopaedic surgeons, excellent compliance has resulted.

In Edinburgh, the introduction of orthopaedic surgeons to screen all neonates greatly reduced the splintage (from six to three per 1000 live births) and the late diagnosis rate.
screening had hitherto been performed by junior paediatric doctors, who often lack specific training and experience in examination for neonatal instability of the hip.4,15-18 The upward trend in unsplinted (observed) cases of neonatal instability of the hip in the later part of this study may reflect the change in orthopaedic surgeons performing the examinations with the programme instigator sharing the regular screening with a colleague after 1984, then being replaced by a younger colleague upon his retirement in 1994.

Having regular, dedicated examiners is also difficult when using junior staff, but is vital for good results. Malmö, Sweden, had a notably increased incidence of splintage to 35 per 1000 when 22 paediatricians were involved in the screening programme. This reduced to < 10 per 1000 when two paediatricians were responsible.10 Physiotherapists have also been trained specifically to screen for neonatal instability of the hip. In Birmingham, United Kingdom, dedicated physiotherapist screening demonstrated a better detection rate than screening by the paediatric service.19

A radiograph at six months of age is still used as the standard reference test for CDH. However, an earlier diagnosis can result in more effective treatment, along with less surgical intervention.20 It is important to have a safe, effective splintage system such as the Von Rosen splint to treat persisting neonatal instability of the hip. Extending the period of splintage from six to eight weeks eliminated the need for prolonged casting following splint removal,3 as was seen in two cases early in the study. However, on occasions, extremely unstable hips are not controlled by Von Rosen splinting and need operative intervention, as was seen in three of our cases.

Studies that match orthopaedic surgeon recall of operative cases with the true operative incidence, drawn from medical records, suggest a poor correlation.21,22 Despite accurate national medical records being available in New Plymouth for only the last 16 years of this study, the rate of walking CDH was steady over the four decades of the study, and the national database searches of the last 16 years failed to uncover any unknown cases of CDH babies born in New Plymouth, thereby lending weight to the validity of the figures over the 40 years.

The overall splintage rate of 1.6%, roughly ten times the expected incidence of walking CDH, has remained steady throughout the study. The safety of the Von Rosen splint, along with the small number of babies with neonatal instability of the hip that were felt to have stabilised at re-check but were then found to be dislocated on the six-month radiograph, may have contributed to the ongoing high splintage rate. Neonatal hip ultrasound is advocated by Graf and Wilson23 and Harcke et al24 as an adjunct to clinical screening, but is unavailable in New Plymouth. On routine ultrasound screening, 90% of abnormalities resolve in the first nine weeks.25 There are many false positives, which require repeat examination at a cost to both staff and equipment. The splintage rate can be reduced with ultrasound examination,25 but this does not eliminate failures of splintage,25 nor does it detect 100% of cases.22 The introduction of universal ultrasound screening in Germany has reduced the rate of surgical treatment of CDH to a level comparable with well-established clinical screening programmes.22 Dezateux and Rosendahl26 concluded that extending clinical screening to include universal ultrasound examination is not justified either ethically or scientifically.

### Table I. Breakdown of results from each decade of the study

<table>
<thead>
<tr>
<th>Period</th>
<th>Number of births</th>
<th>Number of neonatal instability of the hip</th>
<th>Number splinted</th>
<th>Number not splinted</th>
<th>Number of splint failure</th>
<th>Number late-presenting</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964 to 1975</td>
<td>10 103</td>
<td>159 (1.6)</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>1975 to 1985</td>
<td>10 554</td>
<td>672 (1.6)</td>
<td>172 (1.6)</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1985 to 1994</td>
<td>10 823</td>
<td>426</td>
<td>167 (1.6)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1994 to 2004</td>
<td>10 083</td>
<td>541</td>
<td>165 (1.6)</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>41 563</td>
<td>1639</td>
<td>663 (1.6)</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>

* 672 is for 1964 to 1985 combined

### Table II. Neonatal instability of the hip screening programme failure rates

<table>
<thead>
<tr>
<th>Author/s</th>
<th>Location</th>
<th>Year</th>
<th>Failure rate (per 1000 live births)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doig and Shannon15</td>
<td>Christchurch, NZ</td>
<td>1970 to 1973</td>
<td>0.60†</td>
</tr>
<tr>
<td>Rao and Thurston16</td>
<td>Wellington, NZ</td>
<td>1973 to 1982</td>
<td>0.72†</td>
</tr>
<tr>
<td>Smaill17</td>
<td>Wellington, NZ</td>
<td>1963 to 1966</td>
<td>0.83†</td>
</tr>
<tr>
<td>Duppe and Danielsson10</td>
<td>Malmö, Sweden</td>
<td>1956 to 1999</td>
<td>0.16†</td>
</tr>
<tr>
<td>Mitchell18</td>
<td>Edinburgh, Scotland</td>
<td>1962 to 1968</td>
<td>0.28†</td>
</tr>
<tr>
<td>Chan14</td>
<td>SA, Australia</td>
<td>1988 to 1993</td>
<td>0.46†</td>
</tr>
</tbody>
</table>

* late-presenting (walking) congenital dislocation only
† late-presenting (walking) congenital dislocation plus failures of splintage
Both the very young age at the time of splinting, before adduction contractures associated with CDH have developed, and the method of splintage to avoid rigid abduction and flexion of the hips, are felt to have contributed to the very low rate of AVN in this study. Nakamura et al. reported AVN in 12.3% of patients treated for high dislocation with a Pavlik harness. However, the mean age of application was 4.8 months, and the mean duration of treatment was 6.1 months. In neonates, the Von Rosen splint can hold the great majority of unstable hips reduced with no more than 60° abduction and 90° flexion, which was the protocol for this study. Persistently unstable hips that require abduction greater than 60° will need other treatment, as splinting beyond this point is thought to put the femoral head at greater risk of AVN.

Similarly, whereas the effectiveness of the Von Rosen splint in stabilising neonatal instability of the hip in this study compares favourably with reported rates of failure of Pavlik harness treatment (from 1% to 30%) in treating hip instability, many of these studies were dealing with infants well beyond the neonatal period, when the Von Rosen splint should not be used.

Although clinical screening for neonatal instability reduces the incidence of CDH our results demonstrate that an orthopaedic-based neonatal hip instability screening programme is simple, efficient, and reduces the incidence of late presenting CDH by 93%.

Supplementary material

A further opinion by Mr M. Benson is available with the electronic version of this article on our website at www jbjs org uk

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References