

6 weeks with the von Rosen splint is sufficient for treatment of neonatal hip instability

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Background There is no consensus on the optimal treatment time for unstable hips in the newborn. We analyzed the efficiency of a treatment program that has been used for 10 years at our hospital, in which all unstable hips (subluxatable, Barlow-positive and Ortolani-positive) are treated with the von Rosen splint for 6 weeks.

Patients and methods Between 1988 and 1997, 32,171 children were born alive at the hospital. During this period 247 children had a clinically unstable hip diagnosed. 223 of the 247 children underwent a radiographic follow-up after 5–15 years.

Results 1 patient with bilateral instability and treated with a splint for 6 weeks showed a dislocated left hip at the radiographic examination at 8 months, which is part of the screening program, and needed operative treatment. 1 patient did not follow the treatment program and showed a dislocated hip at the age of 3. Another 4 patients required more treatment than the 6 weeks with the splint.

We found no dysplastic hips at the radiographic follow-up. There was no late dysplasia and there were no late dislocations in children born in Lund between 1988 and 1997 who were diagnosed at other Swedish centers that treat developmental dysplasia of the hip (DDH).

Interpretation We conclude that the present screening and 6-week treatment in a von Rosen splint prevent almost all cases of late dysplasia and late dislocation of the hip.

in the screening procedure, the splinting technique, the duration of splinting, and the follow-up routines (Emneus 1966, Fredensborg 1976, Palmén 1984, Sahlstrand et al. 1985, Krikler and Dwyer 1992). We analyzed the efficiency of a treatment program that has been used for 10 years in Lund, Sweden, in which subluxatable (unstable, but not dislocatable) and Barlow-positive and/or Ortolani-positive hips are treated with the von Rosen splint (Figure 1) for 6 weeks. With this program, we reduced the treatment time in the von Rosen splint from 12 to 6 weeks and sonography was introduced as a diagnostic tool for NIH.

Patients and methods

During the 10-year period 1988–1997, 32,171 children were born alive at the University Hospital in Lund. The pediatricians routinely examined all hips during the first days of life, and those hips that were judged to be unstable were referred for



Figure 1. The von Rosen splint.

It is generally accepted that early treatment of Neonatal Instability of the Hip (NIH) prevents dislocation (Palmén 1984). There are, however, variations

Table 1. Treatment program for neonatal hip instability

Time of examination and finding	Treatment
Neonatal hip instability at birth	Splinting for 6 weeks
6 weeks	Examination with ultrasound
stable	Splinting discontinued
unstable	Splinting extended 3 weeks, then repeat examination
2 weeks after completion of splinting	Examination with ultrasound
stable	No further ultrasound examinations
unstable	Splinting extended 3 weeks, then repeat examination
8 months of age	Examination with radiography
normal	No further follow-up examinations
dysplasia	Further radiographic follow-up and/or abduction splint until normalization

a second examination in the orthopedic department by two senior orthopedic surgeons. During this period, 247 children (68 boys and 179 girls) had an unstable hip diagnosed. In doubtful cases sonography was performed, but in cases with clear clinical instability, treatment was started with a von Rosen splint. The NIH was left-sided in 137 children, right-sided in 41, and bilateral in 68. In 1 child the side of instability could not be determined from the patient's medical record. 4 children with teratological dislocations were excluded from this analysis. All 247 children were treated with the von Rosen splint for 6 weeks, after which the hips were re-examined clinically and with sonography using an anterior dynamic technique (Harcke et al. 1984, Dahlström et al. 1986, Harcke and Grissom 1990, Harcke 1992). If the displacement of the femoral head exceeded one quarter of its diameter, measured by sonography, the hip was diagnosed as being unstable. If the hips were stable, treatment was discontinued. If the hips were unstable, treatment was extended for 3 weeks more. 2 weeks after completion of the treatment, a repeat examination with sonography was performed. At 8 months, a final clinical and radiographic examination was done. Radiographs were taken in the anteroposterior direction with the legs straight. The radiographs were analyzed with regard to the presence of dislocation, acetabular dysplasia, and development of the femoral head (Table 1). Furthermore, 223 children (90%) completed a radiographic follow-up after 5–15 years at which time acetabular index (Hilgenreiner 1925), CE-angle (Wiberg 1939) and the spherical index (Fredensborg 1976) were determined. The percentage migration (Reimers 1980) was calculated

in cases with borderline acetabular index or borderline CE-angles. An acetabular index of $< 20^\circ$ was considered normal (Tönnis 1976) and a spherical index of > 35 was considered to be normal (Fredensborg 1976). We used the Severin (1941) definition concerning the CE-angles; for patients aged 6–13 years, $>19^\circ$ is normal and $15\text{--}19^\circ$ is uncertain. We measured CE-angles and spherical index in 275 primary unstable hips (241 patients with 306 unstable hips minus 24 patients with 31 unstable hips) and in 159 normal hips. Acetabular index was measured in 206 hips (and the results from patients who received additional treatment and hips with ossification of the triradiate cartilage have been excluded).

All treatment failures were also evaluated clinically. All other centers in Sweden that treat DDH were contacted and asked whether any late dislocation or dysplastic hip had been diagnosed in patients born in Lund between 1988 and 1997.

Statistics

Differences in paired measurements were tested using paired t-test. If the data distribution was asymmetric, the p-value from the t-test was compared with the p-value obtained from the corresponding non-parametric test: Wilcoxon signed-rank test.

Results

Of the 247 children with NIH, 244 had stable hips after both 6 and 8 weeks, as judged clinically and by sonography. 1 patient with unstable hip at 6 weeks had extended treatment for 3 weeks in a von



Figure 2. Patient no. 1 at 8 months. Left hip dislocated.



Patient no. 1 at 9 years of age. Left hip normal.

Table 2. Treatment failures

Patient no.	Sex	Side	Ultrasound 1 (6 weeks)	Ultrasound 2 (8 weeks)	Radiography at 8 months/5–15 years	Treatment
1	Girl	Bilateral	Stable	Stable	Dislocation/Normal	Tenotomy
2	Girl	Left	Stable	Stable	Minor dysplasia/Normal	Camp splinting 3 months
3	Boy	Bilateral	Stable	Stable	Minor dysplasia/Normal	Camp splinting 3 months
4	Girl	Left	Unstable	Unstable	Normal/Normal	Tenotomy
5	Girl	Bilateral	Unstable	Stable	Normal/Normal	9 weeks of von Rosen splinting
6	Girl	Left	Stable	? ^a	? ^a /Acetabular dysplasia	Chiari osteotomy

^a The patient did not come for follow-up at 8 weeks or at 8 months.

Rosen splint. 1 hip had not stabilized with splinting and was operated on with adductor-psoas tenotomy and hip spica for 8 weeks, followed by an abduction splint for another 3 months. The hip developed normally. 1 girl with left-sided unstable hip did not show up for examination at 8 weeks and 8 months, and the parents had terminated the treatment with the von Rosen splint themselves. She was referred to our orthopedic clinic at the age of 3 years with leg length discrepancy. Radiographs revealed a dislocated hip. She was operated on with open reduction and Chiari osteotomy. After operation, the hip developed satisfactorily and at the latest examination at the age of 8, the patient had no leg length discrepancy and walked without any limp.

Of the 244 children with stable hips, 241 showed no dysplasia at the radiographic examination at 8 months. 2 hips showed minor dysplasia with acetabular indexes of 34° at 8 months and were treated with an abduction splint for 3 months. The radiographic follow-up examination showed normal hips. 1 girl with bilateral instability, and treated with von Rosen for 6 weeks, revealed a dislocated left hip at the radiographic examination

at 8 months. She was operated on with adductor-psoas tenotomy and closed reduction, and the hip developed normally (Figure 2). Thus, altogether 6 children required additional treatment (Table 2).

217 children (275 originally unstable hips) had no dysplasia at the radiographic follow-up at 5–15 years. Of the remaining 24 children (31 unstable hips), 19 would not participate at the late radiographic follow-up and 5 patients were living abroad. These 24 patients all had normal radiographs at the 8-month radiographic control.

At the 5–15 year radiographic follow-up, the mean CE-angle was 30° (15–44) in the 275 primary unstable hips and 29° (19–45) in the 159 normal hips. The mean acetabular index was 14° (5–27) in 206 unstable hips and 14° (4–23) in 111 normal hips. The mean spherical index was 48% (37–52) for the 275 unstable hips and 48% (36–50) for the normal hips (Table 3). We found 9 hips with borderline acetabular index and 9 hips with borderline CE-angles (Table 4). The radiographs were re-evaluated. All had normal Reimers indexes below 20% and were not regarded as dysplastic. We found no hips with spherical index below 35.

Table 3. CE-angles, acetabular indices and spherical indices. P-values for comparison of unstable and stable hips in unilateral cases

	Unstable hips ^a	"Normal" hips ^a	Mean difference between unstable and normal hips	95% confidence interval	P-value ^b
CE-angle	30 (19; 41)	29 (21; 39)	0.7	0.36–2.2	0.007
Acetabular index	14 (7; 21)	14 (6.6; 21)	0.3	-0.42–1.1	0.4
Spherical index	48 (44; 51)	48 (43; 50)	0.1	0.006–0.06	0.04 ^c

^a Values are mean (2.5%; 97.5% percentile)
^b Only unilateral cases (n = 159) are used for comparison of unstable and stable hips (paired t-test).
^c When Wilcoxon signed-rank test was used, the p-value was 0.07.

Table 4. The 17 hips (16 children) with borderline angles at the 5–15 year follow-up

Hip	Age year	CE-angle	Acetabular index (%)	Spherical index (%)	Migration (%)
1	11	19	16	48	17
2	10	19	20	49	9
3 ^a	8	19	17	46	19
4 ^a	8	19	19	46	19
5	6	19	17	43	4
6	6	19	19	45	15
7	5	19	18	47	9
8	8	16	20	46	11
9	7	15	24	46	17
10	11	31	21	49	4
11	8	37	21	49	16
12	6	27	21	48	4
13	6	25	21	50	11
14	10	21	22	48	14
15	8	26	22	47	12
16	8	20	22	48	14
17	6	20	27	47	9

^a Same patient with bilateral unstable hips

At the other centres treating DDH in Sweden, no late CDH had been diagnosed in children born in Lund 1988–1997. In unilateral cases (n = 159), we compared unstable hips with the stable side and found significant differences for CE-angles (p = 0.007) and for spherical indexes (p = 0.04), but not for acetabular indexes (p = 0.4) (Table 3).

Discussion

The frequency of children treated for NIH in Lund was 7.7 in 1,000. The mean frequency of treatment in Sweden has been estimated to be 12 in 1,000 by

Palmen (1984). The incidence of congenital dislocation of the hip before the introduction of screening in Sweden was 0.8 in 1000 (Palmen 1984). The expected number of patients with dislocated hips in our material, without screening and treatment, would thus have been about 25. Our treatment program with 6 weeks of splint immobilization was not sufficient in 6 cases (Table 2). The dislocated hip (no. 1) was discovered at the radiographic examination, which is part of the screening program at 8 months of age. Whether extended treatment with the von Rosen splint would have prevented the dislocation or not is impossible to know. It is, however, possible that additional use of static ultrasound would have revealed a dysplasia even though the hip was stable at 6 weeks (Graf 1992). Static ultrasound investigation may also have contributed to early diagnosis of the 2 hips with minor dysplasia at 8 months (numbers 2 and 3). 1 hip (no. 4) did not become stable even with the treatment extended to 12 weeks, and had probably not become stable without operation 1 hip (no. 5) stabilized after 3 weeks of extended treatment. The last patient (no. 6) did not follow instructions for treatment or screening, and these types of failures are impossible to avoid in any screening or treatment program.

Our study was not undertaken to reduce the number of patients undergoing treatment, but rather to reduce the treatment time. 8 weeks of treatment has been shown to be sufficient (Sahlstrand et al. 1985). Some authors have recommended 6 weeks of treatment for unstable hips and 3 months for dislocatable hips (Düppe and Danielsson 2002). In order to show that 6 weeks of treatment is sufficient for both unstable and dislocatable hips, a late

radiographic investigation was necessary to prove that no late dysplasia had occurred.

The second examination with sonography did not contribute to the diagnosis of instability, and as a consequence we now perform sonography only at 6 weeks. It may be of value to adopt static and dynamic approaches at the same time when using sonography after 6 weeks (Graf 1992, Poul et al. 1998). The distribution of CE angles and spherical indexes at the 5–15-year radiographic follow-up are similar to those presented by Fredensborg (1976). The small but significant difference in the CE-angle and the spherical index between the normal and the affected hip in unilateral cases (Table 4) is not considered to have any clinical relevance.

We found no late dysplasia at the radiographic follow-up among the 241 patients with standard treatment, although some of the measurements were borderline values. No late dislocation or dysplasia in children born 1988–1997 in Lund has been diagnosed at Swedish centers treating DDH. It is unlikely that a dislocated hip would not be recognized in Sweden. However, it is possible that a dysplastic hip without symptoms might not be diagnosed. If we discount patients born in Lund between 1988 and 1997 who have either moved abroad with a dislocated hip or have an asymptomatic dysplastic hip which has not been recognized, we can conclude that the screening and treatment program presented here prevents almost all cases of congenital dislocations and late dysplasia of the hip.

Author contributions

JG measuring radiographs. GH study design, data collection, analyzing results. HL-P study design, data collection, analyzing results, manuscript.

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