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Reduction of a Dislocation of the Hip Due to Developmental Dysplasia: Implications for the Need for Future Surgery

By Scott J. Luhmann, MD, George S. Bassett, MD, J. Eric Gordon, MD, Mario Schootman, PhD, and Perry L. Schoenecker, MD

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Background: Recent reports on the treatment of a dislocation of the hip due to developmental dysplasia have documented conflicting data on the importance of the ossific nucleus in the development of postreduction ischemic necrosis. Delaying reduction until the ossific nucleus is present bypasses the time-period of maximal osseous remodeling of the hip, thereby possibly increasing the need for future operations. We hypothesized that hips with an ossific nucleus are more likely to have subsequent reconstructive procedures.

Methods: A retrospective review of the medical records at two tertiary-care children’s hospitals was completed to identify all patients who had had reduction of a dislocation of the hip due to developmental dysplasia, performed between 1979 and 1993, when they were less than two years old. Patients were excluded if the medical records or radiographs were inadequate, the duration of follow-up was less than three years after the final reduction, a previous reduction had been performed at an outside facility, or the patient had a neuromuscular disease or a teratologic dislocation. We identified 124 patients (153 hips) who satisfied the criteria for inclusion. The average age at the time of the reduction was eleven months, and the average duration of follow-up was 7.2 years.

Results: Overall, fourteen of the sixty-three hips without an ossific nucleus had a reconstructive procedure: thirteen had a varus rotational osteotomy of the proximal part of the femur and one had a combined pelvic and varus rotational femoral osteotomy. Forty of the ninety hips with an ossific nucleus had a reconstructive procedure: twenty-seven had a varus rotational osteotomy, eight had a pelvic osteotomy, and five had a combined pelvic and varus rotational osteotomy (p < 0.05). In addition, secondary reconstructive procedures were performed in 17% (ten) of the fifty-nine patients who were less than six months old and in 35% (thirty-three) of the ninety-four patients who were at least six months old, which was a greater than twofold increase. The effect of age was further emphasized at the other age cutoff points.

Conclusion: Delaying the reduction of a dislocated hip until the appearance of the ossific nucleus more than doubles the need for future surgery to make the hip as anatomically normal as possible. Despite finding a slight increase in the rate of ischemic necrosis after reduction of the hips without an ossific nucleus, we advocate early reduction of a dislocation of a hip due to developmental dysplasia to optimize the development of the hip with the minimum number of operations.

Level of Evidence: Prognostic study, Level II-1 (retrospective study). See Instructions to Authors for a complete description of levels of evidence.

Recent reports have documented conflicting data on the importance of the presence of the ossific nucleus in the development of postreduction ischemic necrosis in dislocations due to developmental dysplasia of the hip. The presence of the ossific nucleus has been theorized to confer protection against ischemic necrosis after reduction. Animal studies have demonstrated that the presence of the ossific nucleus increases the stiffness of the femoral head, which hypothetically would reduce the compression of the vascular system of the femoral head at reduction. In a previous report, we failed to identify an association between the status of the ossific nucleus and the prevalence of ischemic necrosis. With
The primary indication for a varus rotational osteotomy...
of the proximal part of the femur at the time of the reduction was the need to improve the stability of the reduction; the osteotomy was included in the analysis as a reconstructive procedure. To reduce the risk of development of ischemic necrosis, a varus rotational osteotomy was not performed, at the time of the reduction, to treat decompression of the femoral head.

Radiographs performed at the time of the reduction were used to determine the status of the ossific nucleus. The ossific nucleus had been absent in sixty-three hips and present in ninety hips. In patients who were less than twelve months old, the ossific nucleus had been absent in fifty-seven hips and present in twenty-seven hips. In patients who were more than twelve months old, it had been absent in six hips and present in sixty-three.

Five attending pediatric orthopaedic surgeons had been involved in all of the reductions and had used similar treatment algorithms and techniques. Secondary periacetabular pelvic osteotomies and varus rotational osteotomies were performed after documentation of inadequate remodeling of the hip joint so that the long-term prognosis of the joint would not be jeopardized. The use of reconstructive procedures, their type and timing, was determined by the attending physician. The primary indications for secondary reconstructive procedures were failure of the acetabulum to undergo progressive development after reduction to within normal limits (for a minimum of three years after the reduction) and subluxation of the hip joint. In hips with acetabular dysplasia, without subluxation, the decision for reconstructive surgery was made on the basis of the age of the patient, the appearance and morphology of the hip joint, and the site of primary osseous abnormality. The acetabular index was used to follow the development of the hip after the reduction. The guidelines for normal hip development were an acetabular index that was <25° at the age of one year, <20° between two and three years of age, <15° at six years of age, and <10° at ten years of age.

**Statistical Methods**

We used SAS software (Statistical Analysis System, Cary, North Carolina) to perform all analyses. Chi-square tests were used to statistically test the association between the number of reconstructive procedures and the age at which reduction was performed. For patients with bilateral involvement, each hip was considered an independent occurrence for purposes of the statistical analysis. A p value of ≤0.05 was considered significant.

**Results**

The mean age of the fifty-one patients (sixty-three hips) in whom the ossific nucleus was absent at the time of the reduction was six months (range, one to seventeen months), and the mean age of the seventy-three patients (ninety hips) in whom it was present was fourteen months (range, three to twenty-three months). One hundred and thirty-six (89%) of the 153 hips were initially managed with closed reduction, and seventeen were managed with open reduction. Of the 136 initial closed reductions, 112 had a successful result and twenty-four failed to maintain a concentric reduction. Of the seventeen initial open reductions, fifteen had a successful result and two failed. Overall, twenty-six hips (twenty-four that had a closed reduction and two that had an open reduction) resubluxated or redislocated after the initial reduction; twenty-four of them were successfully relocated at the second reduction, which was always an open procedure. Both hips that had two unsuccessful reductions were successfully reduced at the third reduction, which was an open procedure.

In the sixty-three hips without an ossific nucleus, fourteen (22%) had a reconstructive procedure; two hips had a varus rotational osteotomy at the time of the initial reduction, and twelve had a secondary osteotomy (eleven had a varus rotational osteotomy and one, a combined varus rotational and pelvic osteotomy). In the ninety hips with an ossific nucleus, forty (44%) had a reconstructive procedure; nine had a varus rotational osteotomy at the time of the primary reduction, and thirty-one had a secondary osteotomy. The secondary reconstructive procedures included eighteen varus rotational osteotomies, eight pelvic osteotomies, and five combined varus rotational and pelvic osteotomies. The rate of reconstructive procedures in the hips with an ossific nucleus was double that in the hips without an ossific nucleus (p < 0.05).

The effect of age at the time of the reduction was assessed with use of six, nine, twelve, fifteen, and eighteen months of age as cutoff points (Table I). A secondary procedure was performed in ten (17%) of the fifty-nine patients who were less than six months old compared with thirty-three (35%) of the ninety-four patients who were more than six months old. The

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**Table I: Frequency of Reconstructive Procedures According to the Age at the Time of the Reduction**

<table>
<thead>
<tr>
<th>Age at Time of Reduction</th>
<th>No. of Hips That Had a Reconstructive Procedure</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6 mo (n = 59)</td>
<td>10 (17%)</td>
<td>0.0154</td>
</tr>
<tr>
<td>&lt;9 mo (n = 79)</td>
<td>12 (15%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>&lt;12 mo (n = 84)</td>
<td>13 (15%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>&lt;15 mo (n = 100)</td>
<td>20 (20%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>&lt;18 mo (n = 130)</td>
<td>26 (20%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>≥6 mo (n = 94)</td>
<td>33 (35%)</td>
<td></td>
</tr>
<tr>
<td>≥9 mo (n = 74)</td>
<td>31 (42%)</td>
<td></td>
</tr>
<tr>
<td>≥12 mo (n = 69)</td>
<td>30 (43%)</td>
<td></td>
</tr>
<tr>
<td>≥15 mo (n = 53)</td>
<td>23 (43%)</td>
<td></td>
</tr>
<tr>
<td>≥18 mo (n = 23)</td>
<td>17 (74%)</td>
<td></td>
</tr>
</tbody>
</table>

*Chi-square test.
Interestingly, in our analysis, we did not find an increase in sec-
ung to remodel the dysplasia toward normal alignment

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necrosis
ondary reconstructive procedures, or an increase in ischemic
subluxated hip joint provides po or stimulation of the acetab-

skeletal growth. Normal development of the hip joint is de-
pared with open reduction, approach of the open reduction,

Our study demonstrated that pediatric and young adults had significantly different outcomes in terms of the need for secondary reconstructive procedures. The younger group demonstrated a significantly higher need for these procedures compared to the older group. This finding suggests that early intervention may be crucial for achieving better outcomes.

Analysis of other factors, such as the side of the disloca-
tion, treatment with a Pavlik harness, preoperative traction,
 unilateral compared with bilateral involvement, closed com-
pared with open reduction, approach of the open reduction,
and failed primary reduction, demonstrated no differences with respect to the frequency of surgica-

The data were additionally analyzed to count concomi-
tant operations, such as a varus rotational osteotomy and pel-
ic osteotomy, as two separate reconstructive procedures. The
premise for this was based on the concept that more severely
dysplastic hips would require osteotomies on both sides of the hip. However, when this analysis was completed, no new sig-
nificant findings were demonstrated with respect to patient age or the status of the ossific nucleus.

Analysis of other factors, such as the side of the disloca-
tion, treatment with a Pavlik harness, preoperative traction,
 unilateral compared with bilateral involvement, closed com-
pared with open reduction, approach of the open reduction,
and failed primary reduction, demonstrated no differences with respect to the frequency of surgica-

Discussion

The long-term goal of the treatment of developmental dys-
plasia of the hip is an acetabulum and femoral head that
are within the normal range of alignment at the completion of
skeletal growth. Normal development of the hip joint is de-
pendent upon many factors; however, the primary factor is
concentric reduction of the femoral head within the acetabulum. After reduction of the hip joint, long-term mainte-
nance of the concentric reduction is essential to ensure
continued development into the normal range. In addition, a
subluxated hip joint provides poor stimulation of the acetab-
ulum to remodel the dysplasia toward normal alignment. Inter-

Interestingly, in our analysis, we did not find an increase in sec-
ondary reconstructive procedures, or an increase in ischemic necrosis, when the hips required a secondary reduction be-
cause of subluxation. Four (44%) of the nine hips with is-
chemic necrosis underwent a reconstructive procedure (a
pelvic osteotomy and a varus rotational osteotomy in two hips
each) compared with fifty-four (35%) of all 153 hips in this
study. Because of the low frequency of ischemic necrosis in our
patient population, we could not demonstrate whether it had
an effect on the need for secondary reconstructive procedures.

The capacity of the acetabulum to resume normal
growth after reduction is dependent not only on the age of the

patient at reduction but also on the inherent remaining
growth potential of the acetabulum. The potential for growth
and remodeling of the hip joint is maximal at birth and de-
clines thereafter. Lindstrom et al. demonstrated that early
treatment led to the best acetabular development, with the
lowest acetabular indices in patients who were less than one
year old and the highest in patients who were more than two
years old. In general, the earlier the reduction of the hip the
better its radiographic appearance, and hence the better its
function. Malvitz and Weinstein, in a report on the long-
term results in 152 hips, found that the early reductions were
associated with better functional results, less proximal growth
disturbances, and fewer degenerative changes. Additionally,
when the radiographic results were less than anatomic, func-
tion tended to deteriorate over time. Unfortunately, the age
beyond which a dysplastic hip cannot be expected to return
to normal range is unknown. Analysis of our data
demonstrates early reduction of a dislocation of the hip that is
due to developmental dysplasia, thereby minimizing the need for
future reconstructive procedures. Despite the findings of this
analysis, the development of the acetabulum is most depend-
ent on the concentric reduction of the femoral head within
the acetabulum. The status of the ossific nucleus and the age
of the patient at the time of the reduction most likely play a
minor role in the development of the hip compared with that
played by the location of the femoral head.

A review of the literature on developmental dysplasia of
the hip demonstrated that the frequency of secondary recon-
structive procedures after reduction has ranged from 38% to
80% in longer-term follow-up studies. In a study of forty-nine hips, reported that the overall frequency
of secondary procedures was 67%. In that study, the rate of sec-
ondary procedures was 29% for patients who were less than
twelve months old at the time of reduction, 49% for those who
were twelve to twenty-four months old, and 79% for those who
were more than two years old. Roos et al., in a study of twenty-nine hips that had a medial open reduction, reported
that the overall frequency of secondary procedures was 38%.
The mean age of the patients who had not had a reconstructive
procedure was 7.2 months at the time of the reduction, whereas
the mean age of the patients who had a secondary sur-
gery was sixteen months at the time of reduction. There is
evidence in the literature that hips that are concentrically reduced
earlier in life undergo fewer secondary reconstructive proce-
dures to normalize the hip joint. Interestingly, our data
demonstrated three significantly (p < 0.05) distinct age-groups: less
than six months of age, six to seventeen months of age, and
eighteen months of age or older. This finding most likely repre-
ts a continuum of the acetabular response to the reduction,
with early reductions (those performed in patients who are less
than six months old) associated with the best acetabular re-
response; reductions in the six to seventeen-month age-group,
with a moderate response; and those in the eighteen month
or older age-group, with the least response. The duration of
follow-up for our patients ranged from three years to sixteen
years and four months. A longer duration of follow-up will un-
doubtedly show an increase in the number of future operations for both groups. On the basis of our experience, we believe that it is unlikely that the relative difference between the groups will change enough to alter the findings of this analysis.

The ossific nucleus can usually be visualized in normal hips at around six to eight months of age. However, in dislocated hips, the ossific nucleus may not be seen until up to seventeen months of age. Delaying reduction until visualization of the ossific nucleus has been advocated as a way to minimize the risk of development of ischemic necrosis of the femoral head. Our concern with this approach was that the delay would increase the need for secondary reconstructive procedures since the time of maximum acetabular remodeling would be bypassed. A delay in the reduction of a dislocated hip until the appearance of the ossific nucleus increased the frequency of reoperative procedures.

References