Closed Reduction for Treatment of Developmental Dysplasia of the Hip in Children

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Abstract

Although many studies have analyzed the success rates of closed reduction and spica casting for the treatment of developmental dysplasia of the hip (DDH) in children, the definition of success for this procedure is not standardized in the literature.

We retrospectively reviewed our experience with closed reduction for treatment of DDH in 30 children (35 hips) over an 8-year period to determine the success rates of this procedure on the basis of how success is defined. In only 1 patient (2 hips, 6%) were the hips unable to be concentrically reduced with sufficient stability at the time of closed reduction. In 10 (30%) of the other 33 hips, the acetabulum failed to develop sufficiently after closed reduction, and a secondary surgery was required a mean of 22 months after cast removal. Four (12%) of the 33 hips developed radiographic evidence of avascular necrosis.

Therefore, the success rate of closed reduction for DDH varies markedly depending on how success is defined.

Closed reduction of the hip with application of a spica cast remains the preferred treatment for children presenting with developmental dysplasia of the hip (DDH) after the age of 6 months and for children in whom the Pavlik harness has failed to provide a satisfactory concentric reduction. To understand the success rate of this procedure, one must define the results of successful closed reduction—either stable reduction of the femoral head into the acetabulum or acetabular maturation sufficient to avoid secondary surgery for persistent acetabular dysplasia.

Our review of studies of closed reduction for DDH reveals that the reported success rates for this procedure not only vary markedly across clinical series but also depend on how success is defined:

- When successful reduction is defined as resulting in stable concentric reduction of the hip, success occurs in 57% to 88% of cases.[1-6]
- Alternatively, when successful reduction is defined as obviating the need for secondary surgery, success occurs in 33% to 88% of the same cases.

The objective of this study was to analyze the definition-dependent success rates of closed reduction of the hip for DDH at Rainbow Babies and Childrens Hospital in Cleveland, Ohio.

Materials and Methods

We reviewed the medical records of all patients who underwent closed or open reduction of the hip for DDH at the Rainbow Babies and Childrens Hospital from 1992 to 2000. Forty-five patients were identified as having undergone closed reduction over the 8-year period of this study. Patients were excluded if their follow-up was less than 20 months after cast removal unless there was documentation that a secondary procedure was performed before 20 months. Ten patients were excluded because of lack of follow-up information. Five patients were excluded for having a preexisting medical condition that contributed to their hip dysplasia. The remaining 30 patients (6 males, 24 females) represented 35 hips.

Dysplasia was unilateral in 25 patients and bilateral in 5 patients. Closed reduction was performed at a mean age of 6 months (range, 3 weeks to 16.5 months). Sixty-four percent (19 patients) of patients were less than 6 months old at the time of closed reduction, 27% (8 patients) were age 6 months to 12 months, and 9% (3 patients) were older than 12 months.

Twenty-six (74%) of 35 hips had previously been treated with a Pavlik harness. Seven hips (20%) did not receive treatment before closed reduction, and information about prior treatment for 2 hips (6%) was unavailable. Seventeen hips (49%) were placed in Bryant traction for a mean of 8 days (range, 7-14 days) before closed reduction. This time frame was selected by each surgeon empirically and was not based on previous evidence in the literature. Seventeen hips (49%) were not treated with preoperative traction, and 1 hip (2%) lacked documentation regarding whether traction was used or not. An adductor tenotomy was performed on 19 hips (54%) at the time of closed reduction; 12 hips (34%) did not have a tenotomy performed; and, for 4 hips (12%), there was no documentation regarding tenotomy.

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Am J Orthop. 2007;36(2):82-84.

Table I. Association Between Closed Reduction and Spica Casting for Developmental Dislocation of Hip and Need for Secondary Surgery*

Treatment	Hips (N)	Successful Outcomes (n)	Success Rate (%)	*P*
Pavlik harness	26	18	69	.91
No Pavlik harness	7	5	71	
Abduction orthosis	21	16	76	.71
No abduction orthosis	10	7	70	
Traction	17	12	71	.714
No traction	17	11	65	
Adductor tenotomy	19	13	68	.355
No adductor tenotomy	12	10	83	

*Strength of association was determined by χ^2 analysis. An outcome was considered successful if the hip remained reduced and no secondary surgery was required.

Table II. Success Rates of Closed Reduction and Spica Casting for Treatment of Developmental Dislocation of Hip*

Series	Hips (N)	Reduced (%)	Secondary Surgery	AVN[1] (%)	AVN[2] (%)
Malvitz & Weinstein[7]	152	NR	8	60	45
Kahle et al[3]	47	57	12	4	4
Quinn et al[4]	90	58	21	10	6
Race & Herring[5]	59	68	26	33	20
Zionts & MacEwen[6]	51	75	66	39	6
Joseph et al[2]	51	78	27	5	5
DeRosa & Feller[1]	85	88	5	14	0
Current series	35	94	30	12	6

*AVN[1] indicates percentage of hips with any degree of radiologic change consistent with avascular necrosis; AVN[2], percentage of hips manifesting clinically significant avascular necrosis; NR, information not reported.

The duration of immobilization in the spica cast was 12 weeks (range, 2-21 weeks). Twenty-one (60%) of 35 patients were treated with abduction splinting after removal of the spica cast. Twelve patients (34%) of 35 hips were not splinted, and 2 (6%) had no documentation of whether splinting was used. The patients were followed for a mean of 45 months after the procedure (range, 5-87 months).

The criterion for a successful outcome was determined for 2 situations:

(a) stable reduction of the femoral head into the acetabulum at the time of closed reduction

and

(b) sufficient development of the acetabulum after closed reduction to avoid a secondary procedure.

A χ^2 analysis was used to determine the strength of association between the need for a secondary procedure and treatment with a Pavlik harness, abduction orthosis, prereduction traction, or adductor tenotomy. Only those hips for which complete data existed regarding a given treatment modality were included in the analysis.

Results

In 33 (94%) of the 35 hips, the femoral head remained stably reduced into the acetabulum at the time of closed reduction. Both hips (6%) in 1 patient were unstable after closed reduction, and open reduction subsequently was performed. Twenty-three (70%) of the 33 hips went on to develop sufficient acetabular depth to avoid a secondary surgery. The remaining 10 hips (30%) required a secondary procedure a mean of 22 months after removal of the spica cast.

Chi-square analysis showed no significant association between any of the treatment modalities and the need for a secondary surgery (Table I). No analysis was performed on independent variables for initial stability at closed reduction because only 2 hips had a failed outcome.

Of the 33 hips that were reduced, 4 (12%) developed avascular necrosis (AVN). Two of these hips showed mild irregular ossification, while the other 2 developed more severe AVN.

Discussion

The current series of patients represents the most successful result of closed reduction reported to date as defined by the ability to achieve a stable reduction of the hip at the time of closed reduction. There are at least 2 factors that may have contributed to the high rate of success in our patients:

1. Our study involved relatively young patients, with 64% younger than 6 months of age and 36% less than 5 months of age. This high success rate in younger patients highlights both the importance of early detection of DDH and early orthopedic intervention.

2. The second factor may be our acceptance of 70° of hip abduction, but never forced abduction, at the time of closed

reduction to achieve stability. The relatively low rate of AVN in our patients suggests that this amount of abduction is not necessarily harmful.

Our study did not find any statistical difference in outcome when a Pavlik harness or traction was used before closed reduction. Likewise, there was no difference in outcome attributable to performing an adductor tenotomy at the time of closed reduction or using an abduction orthosis after cast removal.

Limitations of our study include lack of intraoperative arthrograms to review, relatively short follow-up, and possible lack of statistical power to detect a difference (because of the small number of hips analyzed for each treatment variable).

The success rate reported in the literature for treatment of the developmentally dislocated hip by closed reduction and spica casting varies and depends on how success is defined (Table II). The lowest success rate of closed reduction was reported by Kahle and colleagues,[3] who found that only 27 (57%) of their 47 hips could be reduced by closed methods. Twenty-three percent of the 11 patients in their series were less than 6 months of age, and 30% (14 patients) were over the age of 1 year, suggesting that a higher proportion of older patients may have contributed to the lack of success in achieving a stable closed reduction. In a long-term follow-up study, Malvitz and Weinstein[7] showed that the younger the patient at the time of reduction, the better the overall function and radiographic appearance of the hip.

The highest success rate of closed reduction reported in the literature to date is the series of DeRosa and Feller,[1] who achieved stable reductions in 88% of hips with a secondary surgery rate of 5%. It is interesting to note that 72% of patients in their study were 6 months of age or younger, suggesting that success of closed reduction improves as patient age declines. Twelve (14%) of the hips in their series displayed "temporary irregular ossification" as described by Salter and colleagues,[8] but no patient developed total AVN according to Salter's criteria, and none developed partial AVN using criteria set by Kalamchi and MacEwen.[9]

Quinn and colleagues[4] examined the effectiveness of preliminary traction in reducing the incidence of AVN and improving the rate of successful closed reduction. Patients were treated in traction for a mean of 3 weeks before closed reduction. Mean age at closed reduction was 7.5 months (compared with 6 months in our study). No difference was noted between the success rate of closed reduction or the incidence of AVN compared with previous studies in which traction was not used. Quinn and colleagues demonstrated a higher success rate in their younger patients, again underlining the importance of age at the time of closed reduction.

Zionts and MacEwen[6] studied DDH in patients between the ages of 1 and 3 years. Thirty-eight (75%) of the 51 hips in their study could be successfully reduced by closed methods, but 66% (34) required a secondary procedure. Use of skeletal traction did not affect the incidence of AVN in this series. Seventeen (33%) of the 51 hips demonstrated at least temporary irregular ossification, with 3 hips (6%) developing clinically significant AVN.

Race and Herring[5] reported a closed reduction success rate of 68% (40 of 69) in patients under the age of 2, with 26% (15 of 69) requiring a subsequent open procedure. Fifty-six percent (33 of 69) of patients developed some radiographic evidence of AVN. Race and Herring believed that the level of initial reduction was the best prognosticator for future outcome. Our study cannot address the issue of quality of reduction because radiographic data were not available.

The rate of successful closed reduction in the series reported by Joseph and colleagues[2] was 78% (40 of 51) with 27% (14 of 51) rate of subsequent open reduction. Joseph and colleagues recommended use of traction to increase the success of closed reduction and to reduce rates of AVN, which occurred in 2% (1 of 51) of hips treated with home traction and in 7% (3 of 41) of hips treated with hospital traction. In our 4 cases of AVN, 3 hips were not treated with traction before closed reduction, but these numbers are too small to draw any statistically significant conclusions regarding efficacy of traction in preventing AVN.

Conclusions

We conclude from this study that the success rate of closed reduction and spica casting for treatment of the developmentally dislocated hip depends on the definition of success. In our series, 94% (33 of 35) of hips could be stably reduced into the acetabulum, although only 70% (23 of 33) did not require a secondary surgery. The most important factor in the success of closed reduction of the hip for DDH may be age at the initiation of treatment. In our study, previous use of a Pavlik harness, short-term prereduction traction, adductor tenotomy, or abduction orthosis after cast removal did not correlate with success rate or development of AVN.

Authors' Disclosure Statement and Acknowledgments

The authors report no actual or potential conflict of interest in relation to this article. No author received financial support for this study.

References

1. DeRosa GP, Feller N. Treatment of congenital dislocation of the hip. Management before walking age. *Clin Orthop.* 1987;225:77-85.
2. Joseph K, MacEwen GD, Boos ML. Home traction in the management of congenital dislocation of the hip. *Clin Orthop.* 1982;165:83-90.
3. Kahle KW, Anderson MB, Alpert J, Stevens PM, Coleman SS. The value of preliminary traction in the treatment of congenital dislocation of the hip. *J Bone Joint Surg Am.* 1990;72:1043-1047.
4. Quinn RH, Renshaw TS, DeLuca PA. Preliminary traction in the treatment of developmental dislocation of the hip. *J Pediatr Orthop.* 1994;14:636-642.
5. Race C, Herring JA. Congenital dislocation of the hip: an evaluation of closed reduction. *J Pediatr Orthop.* 1983;3:166-172.
6. Zionts LE, MacEwen GD. Treatment of congenital dislocation of the hip in children between the ages of one and three years. *J Bone Joint Surg Am.* 1986;68:829-846.
7. Malvitz TA, Weinstein SS. Closed reduction for congenital dysplasia of the hip. Functional and radiographic results after an average of thirty years. *J Bone Joint Surg Am.* 1994;76:1777-1792.
8. Salter RB, Kostuik J, Dallas S. Avascular necrosis of the femoral head as a complication of treatment for congenital dislocation of the hip in young children: a clinical and experimental investigation. *Can J Surg.* 1969;12:44-62.
9. Kalamchi A, MacEwan GD. Avascular necrosis following treatment of congenital dislocation of the hip. *J Bone Joint Surg Am.* 1980;62:876.

This paper will be judged for the Resident Writer's Award.