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ORIGINAL ARTICLE

Outcomes of closed reduction in patients with developmental dysplasia of the hip incorporating open psoas and adductor release and using short leg cast

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ABSTRACT

Background and objectives: Closed reduction and short leg spica casting are the preferred treatment options for children with developmental dysplasia of the hip. This study aimed to show the efficacy behind a standardized closed reduction for managing patients with developmental dysplasia of the hip with concomitant soft tissue releases when indicated and using a short leg plaster of Paris cast to maintain reduction and reporting mid-term results.

Methods: A case series of 95 hips in 84 children aged 6-18 months who had closed reduction, with five years follow up or until next operation, involved in this study. The protocol defines acceptable concentric reduction criteria and the indications for an associated soft tissue release. All the patients were immobilized in a short leg cast for three months. Multiple follow-up radiographs were taken to assess Tönnis grade, Severin grade, acetabular index, and osteonecrosis signs.

Results: A total of 48 hips were Tönnis grade 3/4 hips. At one year, 15 reductions couldn't be maintained, and these patients needed open reduction. Of these 15 failed reductions, 7 patients were Severin 1; others were Severin 2. Of the 80 successful closed reductions, 70 hips were Severin 1. Surgical management for residual dysplasia was offered for 8 hips. Osteonecrosis was seen in 23 hips but was transient in 20. Bilateral hip dislocations and most Tönnis 4 hips were more likely to fail. Two children had severe osteonecrosis.

Conclusions: Closed reduction, with subsequent adductor and psoas releases, when indicated and using a short leg plaster of Paris cast for three months, brings about good mid-term results in children with developmental dysplasia of the hip aged 6-18 months.

Keywords: Developmental dysplasia of the hip, closed hip reduction, open psoas release, short leg cast.

INTRODUCTION

Developmental dysplasia of the hip encompasses a spectrum of pathological changes involving the hip joint that occur in the early years of life and, if left untreated, can have a harmful effect on the affected child. It is ranging from subtle dysplasia to frank dislocation. Soft tissue contractures that stand in the way of acquiring or maintaining a closed reduction must be overcome to decrease the compressive or deforming forces acting upon the vulnerable blood supply to the femoral head and cartilaginous structures. Therefore, a careful history of important risk factors and proper physical examination of all the infants to have a proper diagnosis and treatment of developmental dysplasia of the hip are important to provide the best possible functional result. It is crucial that all health professionals who care for newborns and infants should be trained in a proper way to evaluate the infant hip for instability.

Treating children who have developmental dysplasia of the hip by closed reduction is an accepted form of management for those treated by early splintage with failure or late presentation. Gentle reduction under general anaesthesia demanded to achieve a stable and congruent joint as much as possible. Contractures of the soft tissues, namely the adductor and iliopsoas tendons, if prevent achieving or keeping a reduction must be dealt with to reduce excessive forces acting upon the femoral head. Adductor tenotomy is a widely used procedure which consist of proximal release of the adductor tendon at the anterior aspect of the pubis.

Variable outcomes demonstrated in earlier studies after closed reduction describing many different kinds of techniques[1-6]. There is no agreement about using soft tissue releases, determine a reduction that is accepted or sort and duration of immobilization postoperatively.

Our study explains a standardized management approach involving closed reduction, including open adductor and psoas releases when indicated, and using an above knee short leg plaster of Paris cast. The goals were to evaluate: the efficacy of this protocol to maintain reduction, resolving the dysplastic acetabulum and whether any bony surgeries required, the occurance and grading of the femoral head osteonecrosis[7], and[7] radiological follow up images using the Severin grades[8].

PATIENTS AND METHODS

Case notes and radiographs were reviewed of the children with developmental dysplasia of the hip, who underwent a successful closed reduction at Hawler Teaching Hospital and Helina Centre in Hawler city between January 2015 to January 2020, with a minimum follow-up of five years. The indication for treatment was a subluxated or dislocated hip (Tönnis grades 2 to 4)in a child aged 6-18 months[9].

To determine Tönnis classification and the presence or absence of a center of an ossific nucleus at the time of closed reduction, plain radiograph taken. Follow-up radiographs were analyzed at six weeks, six months, one,

two, and five years postoperatively, and the following measurements were noted: acetabular index [10], signs of osteonecrosis, and the Severin grade at six years of age and the most recent follow-up. The Kalamchi and MacEwen group classification[7] was used to classify the osteonecrosis. The epiphyseal height to width index[11] was measured using radiographs between the ages of 12 and 18 months after the operation and also at final follow-up. The height-to-width index of the head of femur as described by Casaletto et al.[11] was used as a measure of its deformity following treatment, adapting Eyre Brook's use of the index in Perthes' disease[12]. (Table 1).

Table 1: Kalamchi and MacEwen classification of osteonecrosis[7]

Group	
1	Changes affecting the ossific nucleus
2	Lateral physeal damage
3	Central physeal damage
4	Total damage to the head and the physis

For the protocol of using closed reduction of the dislocated hip, an examination of the hip under anaesthesia was carried out. An Ortolani maneuver[13] was performed, and the quality of reduction was assessed, involving the arc of stability in flexion/extension, abduction/adduction, and rotation. If the arc of abduction/adduction between redislocation and comfortable, gravity-assisted abduction was < 30° and/or abduction in 90° flexion was < 45°, an adductor longus release was performed. In case the abducted hip was unstable in extension beyond 90° of flexion, then the psoas tendon was released via a transverse groin incision at the lesser trochanter in the interval between the two muscles, which are adductor brevis and pectineus[16]. The hip(s) were held in the reduced position while a short-leg cast was applied with the hips flexed to > 90° in a comfortable, gravity-assisted abduction. The cast was moulded around the greater trochanter and distal femur and did not extend below the knees, allowing free flexion and extension of the knee and rotation of the hip, as seen in figure 1. The reduction was confirmed with a plain radiograph following the application of the cast. The cast was changed six weeks postoperatively and a plain radiograph was taken to document the containment and the stability of the hip. For a dislocated hip at any stage, removal of the cast done, and the patient was scheduled for open reduction. Then the cast was replaced with an abduction brace three months postoperatively and worn for 23 hours per day for another six weeks. Thus, treatment continued in total for 4.5 months.

Fig.1: Short leg cast

This study carried out using SPSS 25.0 for Windows. Whenever stated, categorical variables are expressed as proportions, and continuous variables are expressed as median (range). For categorical variables, differences between groups were assessed using the Pearson chi-square test or Fisher's exact test.

RESULTS

During the period of the study, 114 hips in 95 children had successful closed reductions. A total of 19 hips in 11 children didn't show up to follow-up, and hence they were excluded. A total of four of these 11 patients moved out of the country, and two didn't show up for the appointments after further surgery was advised (osteotomy of the pelvis; examination under general anaesthesia). In the other five children, follow-up appointments were missed between the ages of two and five years. The demographic data of the remaining 95 hips in 84 children are shown in (Table # 2).

Table 2: The demographics of the children

Variable	**Number (n = 95 hips in 84 children)**
Female : male	76 : 8
Bilateral : Unilateral	10 : 75
Left : Right (in unilateral hips)	46 : 29
Brace treatment before closed reduction	21 children (*25%*)
Tönnis grade at the time of reduction	Tönnis 2 47 hips (*49%*) Tönnis 3 42 hips (*44%*) Tönnis 4 6 hips(*6.3%*)
Ossific nucleus present : not present	49 (*52%*) : 46(*48%*)
Median age (range) in months at the time of reduction	9 (6 to 18)
Soft-tissue release	Adductor and psoas 61 (*64%*) Adductor alone 7 (*7.3%*) No release 27 (*28%*)

The reduction could not be maintained in 9 of 95 hips (9/84 children) in patients with seven unilateral hip dysplasia, and two children had bilateral involvement where one of the hips failed in each patient. A further six hips (3 children) needed open reduction within 12 months of closed reduction because of progressive subluxation.

Therefore, 15 hips in 12 children failed, after which the closed reduction was initially acceptable. This represents an overall failure rate of 15 hips (of 95) and a rate of failure for unilateral hips of 7/75 (9.3%). All 15 failed hips went through an open reduction. A total of 7 of these (54%) were Severin 1 at last following up; the rest were Severin 2 due to minor acetabular dysplasia.

A total of 11 of the 15 failures in closed reductions were Tönnis grade 3 or 4(Tönnis 3: 6 hips, Tönnis 4: 5 hips). In all, 4 of five Tönnis grade 4 hips failed. Only one child with a Tönnis grade 4 hip, which remained reduced, had an acetabuloplasty operation when he was six years old and required a femoral osteotomy and ten children had bilateral developmental dysplasia of the hip, at least one hip failed in 7 children (70%), and both hips failed in three (30%). None of the bilateral hips which were successfully managed developed significant osteonecrosis, and all in the current situation have a good or excellent outcome.

Younger age at the time of closed reduction was associated with failure; out of 76 hips that were 12 months or less at the time of the closed reduction, 14 failed (18%), comparing with one failure in 19 hips (5%) who were older than 12 months. The AI at the time of closed reduction was not regarded as a significant factor.

A total of 12/15 hips from 95 hips in which treatment failed had needed a soft-tissue release, and the other three no soft tissue release is done, compared with 56 hips from the remaining 80 hips of those in whom treatment was successful, soft tissue releases were done in which it may reflect pre-existent instability in those in whom treatment failed.

The 15 hips in 12 children which failed within 12 months were not included in the midterm results, leaving 80 hips in 72 children to do analysis (5 with bilateral developmental dysplasia of the hip in which treatment failed).

The acetabular index decreased in all 80 hips. Further surgery was advised for eight hips (8 children) with an index > 25° two to three years following closed reduction, with two going through two separate operations for residual developmental dysplasia of the hip. The remaining six hips required pelvic osteotomy, three osteotomies of the femur, and three both.

Of the 80 hips, one hip was modified Severin grade 4. All remaining hips were Severin grade 1 or grade 2 at the last follow-up. Of the Severin 2 hips, six of them got minor acetabular dysplasia; three got changes secondary to osteonecrosis, and three had evidence of both.

Osteonecrosis was seen in 23 hips (Table # 3). In 20, this was “transient” (Kalamchi/McEwen 1). There was a minimal decrease in the height of the femoral head in six of these at the latest follow-up. Of the these 20 hips, 16 were Severin 1, and four were Severin 2 (2 of them due to acetabular deformity and 2 with additional minor deformity of the head of the femur).

Severe osteonecrosis (Kalamchi and MacEwen group 3 and 4) was present in two patients. In one, the ossific nucleus was present at the time of the closed reduction, and the child had gone through a femoral and pelvic osteotomy for residual developmental dysplasia of the hip when the age was 2.5 years. One child had Kalamchi and MacEwen group 2 lateral growth arrest.

Of the three hips with clinically significant osteonecrosis (Kalamchi and MacEwen groups 2 to 4), two occurred in the hips which the ossific nucleus was seen at the time of closed reduction.

Table 3: Incidence and Kalamchi and MacEwen classification of osteonecrosis

Types of osteonecrosis (total number of hips= 23	Ossific nucleus present at the time of closed reduction	Soft-tissue release	Prior brace treatment
Transient n = 20	8 (*39%*)	18 (*89%*)	7(*36%*)
Type 2 = 1	1 (*100%*)	1 (*100%*)	0 (*0%*)
Types 3 and 4 (severe) = 2	1 (*50%*)	2(*100%*)	0 (*0%*)

A decreased femoral head epiphyseal height-width ratio (< 0.357) between 12 and 18 months after performing closed reduction was seen in 10 hips, all of which demonstrated evidence of transient osteonecrosis—. Of 12/80 hips which showed a decrease in the height of the head of the femur at the final follow-up, only 5 were Severin 2 as a result.

DISCUSSION

We managed to use a standard way of hip joint reduction closely to treat patients with developmental dysplasia of the hip aged 6 to18 months. We had 16% failure rate, that is failed to maintain a closed reduction which was successful at the beginning. Numerous studies that involve reduction closely[1-6] do not mention rates of their failed treatments and doesn’t mix rates of primary failure (that couldn’t acquire adequately reduced position initially) with secondary ones: we think that the two matters should be divided, an inability to gain an accepted reduction and an inability maintaining that reduction.

The decreased secondary failure rates is shown to have an association with younger age groups at the time of reduction[6], and also with the initial reduction whether it is congruent or not[2,14]. The rate of secondary failure didn’t have a relation to an increasing age at the time of the closed reduction, which is normally anticipated, but to a younger age. Failure of four out of five Tönnis 4 hips occured, with the remaining patient needed operation later. In children with bilateral developmental dysplasia of the hip, there was lower success rate; but still, when closed reduction was successful, the results were as promising as in unilateral patients.

It is agreed that the end result is depending on the status of the initial reduction[2, 14]. Consideration of the soft-tissue obstacles for the hip joint stability done in our standard management in addition to the completeness of the reduction. Most authors only mention an adductor release[6, 15].

While in the cast for six weeks, the femoral head is contained as changes occur to the labral shape, and the acetabulum gradually increases its concavity. Only two

other previous studies describe using a short-leg cast[17,18]. Important practical advantages presented for the child and caregiver, and we think that the above-knee cast allows rotation of the head of the femur to be contained within the acetabulum. During this period, many children manifested a significant improvement in appearance. They showed good or excellent mid-term results with our protocol.

After closed reduction, the ideal period for immobilization is not identified, but the prolonged duration of immobilization is common[5,6,15,19]. Some made use of the degree of dysplasia resolution to guide duration.

We observed superior outcome using a standard period of immobilization of three months in a short leg cast, then six weeks of using an abduction brace, with dysplasia resolution of 90% of hips and having accepted failure rates and secondary operations, with a follow-up of five years at a minimum. It is observed that remodeling of the acetabulum continues after removing the cast or brace. We did not recognize any factor influencing the rate of decreasing the acetabular index or necessary requirements for the secondary operation needed for residual dysplasia.

The rate of secondary operation for residual developmental dysplasia of the hip in our study compares favorably with other studies that quote rates of between 5% and 66%, without mentioning any criteria for secondary surgery[1,3,6,15]. Almost 87% of hips included within modified Severin grade 1 at the latest follow-up. Other studies report Severin 3 and 4 hips in up to 60%[14,19,20].

In 12 of the 20/80 hips with group 1 osteonecrosis, which is regarded as transient and inconsequential,[21] there was permanent evidence of osteonecrosis observed as the decreased height of the head of femur at the latest follow up. However, it was only severe enough to influence the Severin grade in three hips.

Even though there was a likelihood for more group 1 osteonecrosis in those hips which didn't show an ossific nucleus at the time of the closed reduction, 2 of our 3 children with groups 2, 3, or 4 Kalamchi and MacEwen (significant) osteonecrosis happened in hips in whom the ossific nucleus was seen at the time of closed reduction. At present, the presence or absence of the ossific nucleus does not affect the timing of our closed reduction.

In our study, all but one hip which has a femoral head height to width index < 0.357 at 12 to 18 months after closed reduction established changes in the height of the femoral head in the mid-term, although having been graded as having 'transient' osteonecrosis. Maybe a more sensitive determinant of severe osteonecrosis than other grading systems is the epiphyseal height to width ratio. However, more evaluation is needed for three hips with no proof of osteonecrosis or a reduced head height to width ratio at 12 and 18 months formed a subtle decrease in the height of the femoral head later.

We admit that follow-up was not to skeletal maturity in most patients. Nevertheless, we found that by using strict criteria for accepting closed reduction, even though one may be incongruent, and using open soft-tissue release whenever mandatory, good results can be acquired. We do not now recommend closed reduction for Tönnis 4 hips, and hence we now manage these hips with open reduction at approximately 12 months of age.

CONCLUSION

This study supports that closed reduction, with subsequent adductor and psoas release when indicated and using a short leg Plaster of Paris cast for three months, achieves good mid-term results in children with developmental dysplasia of the hip aged 6-18 months. This protocol is not advocated for Tönnis 4 hips.

REFERENCES

1. Shin CH, Yoo WJ, Park MS, et al. Acetabular Remodelling and role of osteotomy after Closed reduction of Developmental Dysplasia of the Hip. J Bone Joint Surg. 2016; 98: 952–7.
2. Ge Y, Cai H, Wang Z. Quality of reduction and prognosis of developmental dysplasia of the hip: A Retrospective study. Hip Int 2016; 26: 335–9.
3. Schur MD, Lee C, Arkader A, et al. Risk factors for Aavascular necrosis after Closed reduction for developmental dysplasia of the hip. J Child Orthop 2016; 10: 185–92.
4. Tiderius C, Jaramillo D, Connolly S, et al. Post closed reduction perfusion Magnetic Resonance Imaging as a predictor of avascular necrosis in Developmental hip dysplasia:a Preliminary report. J Paediatr Orthop 2009; 29:14–20.
5. Rampal V, Sabourin M, Erdeneschoo E, et al. Closed reduction with traction for developmental dysplasia of the hip in children aged between one and five years. J Bone Joint Surg. 2008;90-B:858–63.
6. Murray T, Cooperman DR, Thompson GH, Ballock RT. Closed reduction for treatment of developmental dysplasia of the hip in children. Am J Orthop (Belle Mead NJ) 2007; 36:82–4.
7. Kalamchi A, MacEwen GD. Avascular necrosis following treatment of congenital dislocation of the hip. J Bone Joint Surg. 1980;62-A:876–88.
8. Severin E. Contribution to the knowledge of congenital dislocation of the hip joint. Late results of closed reduction and arthrographic studies of recent cases. Acta Chir Scand Suppl 1941; 84:1–142.
9. Tönnis D. Normal values of the hip joint for the evaluation of X-rays in children and adults. Clin Orthop Relat Res. 1976; 119:39–47.
10. Kleinberg S, Liebermann HS. The Acetabular Index in Infants in relation to congenital dislocation of the hip. Arch Surg. 1936;32(6):1049-54.
11. Casaletto JA, Perry DC, Foster A, Bass A, Bruce CE. The height-to-width index for the assessment of femoral head deformity following osteonecrosis in the treatment of developmental dysplasia. J Bone Joint Surg. 2009;91-A:2915–21.
12. Eyre-Brook AL. Osteochrondritis deformans Juvenilis or Perthes Disease:the results of treatment in recumbency. Br J Surg. 1936; 24:166–82.
13. Ortolani M. Un Segno poco noto c sua importanza per la diagnosi precoce di prelussazione congenital dell'anca. Pediatria (Napoli) .1937:45;129–36.
14. Kim H, Lee T, Ahn T, Jang J. The fate of DDH Hips showing Carilaginous or fibrous tissue filled joint spaces following primary reduction. J Pediatr Orthop. 2017;37(3):184-91.
15. Kim HT, Kim JI, Yoo CI. Acetabular development after closed reduction of developmental dislocation of the hip. J Pediatr Orthop. 2000; 20: 701–8.
16. Tarassoli P, Gargan MF, Atherton WG, Thomas SR. The medial approach for the treatment of children with developmental dysplasia of the hip. Bone Joint J. 2014;96-B:406–13.
17. Schwartz D. Acetabular development after reduction of Congenital Dislocation of the Hip: A follow-up study of fifty hips. J Bone Joint Surg.1965; 47: 705–14.
18. Cooperman D, Wallensten R, Stulberg D. Post-reduction Avascular Necrosis in Congenital Dislocation of the Hip. J Bone Joint Surg Am. 1980;62(2):247-58.
19. Albinana J, Dolan LA, Spratt KF, et al. Acetabular dysplasia after treatment for developmental dysplasia of the hip. J Bone Joint Surg. 2004;86-B:876–86.
20. Fu Z, Yang JP, Zend P, Zhang ZL. Surgical implications for residual subluxation after closed reduction for developmental dislocation of the hip:a long-term follow-up. Orthop Surg 2014; 6: 210–6.
21. Roposch A, Stohr KK, Dobson M. Effect of femoral head ossific nucleus in treatment of hip dislocation: Systematic review with meta-analysis. J Bone Joint Surg. 2009 91-A911–8.