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Outcome of Closed Reduction in Developmental Dysplasia of Hip Joint- A Single-Center Retrospective Study

Yaqoob Sulaiman Almufargi[1]* and Hala Khalaf Alisaii[2]*

[1]*Consultant Paediatric Orthopedic surgeon, Department of Orthopedic surgery, Armed Force Hospital, Muscat, Oman.*

[2]*Orthopedic Resident, Oman Medical Speciality Board, Muscat, Oman.*

***Correspondence:**

Yaqoob Sulaiman Almufargi, Armed Force Hospital, Oman.

Hala Khalaf Alisaii, Oman Medical Speciality Board, Muscat, Oman.

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ABSTRACT

Background: *Developmental dysplasia of the hip (DDH) is a disorder of abnormal development of the hip joint resulting in dysplasia, subluxation or dislocation. Treatment varies from abduction splinting/bracing to surgical reduction and osteotomies depending on patients age and the degree of dysplasia. For the last decades, treatment by closed reduction combined with earlier diagnosis has become the desired and widely accepted approach. These treatment options occasionally result in considerable hip problems like re-dislocation, avascular necrosis and stiffness. There are some good studies done globally but still no studies done in our setting regarding the outcome of closed reduction for the treatment of DDH.*

Objectives: *The aim of this study is to evaluate the outcome of closed reduction in-patient with DDH among Omani population who had attended Armed Force Hospital, Muscat in the period between 2010-2020.*

Expected outcome: *Successful outcome following closed reduction is high and the incidence of complications is low. International Institute of Hip Dysplasia (IHDI) classification is a reliable predictive tool for the success of closed reduction in patient with DDH and related to better scores in Mckay criteria as well as Severin classification.*

Methodology: *In this study, we retrospectively evaluated (36) hips of children, who were diagnosed with DDH and then underwent closed reduction and hip spica cast immobilization followed by abduction splint. We reviewed the success rate and possible complications over the last 10 years. At each follow up, they were assessed clinically and radiographically for redislocation, AVN and stiffness. Last clinical examination was evaluated using Mckay criteria and radiographic imaging was evaluated using Severin classification and osteonecrosis was assessed using Kalamchi score. All children who had DDH as a part of their connective tissue disorder/syndrome or lost to follow up were excluded from the sample of the study.*

Results: *Most patients had unilateral DDH. Only 28% of patients had bilateral DDH. The proportion of hips with a pre-reduction IHDI grade I, II, III, and IV were 8%, 47%, 36% and 8%, respectively. The mean age at the time of closed reduction was 8+/- 4.5 months (range 3- 20 months). Clinical assessment in the last follow up showed that 81% of hips had excellent outcome, 3% of hips had poor outcome and 17% of hips had treatment failure according to the Mckay scoring system. Radiographic analysis demonstrated that 27.8% had excellent outcome (Severin Class I), 19.4 % had good outcome (Severin Class II), 33.3 % had fair outcome (Severin Class III), and 19.5% had poor results (Severin Class IV to VI). A significantly higher incidence of re-dislocation was observed in IHDI grade III and IV. The treatment failure was almost 16.6%. 50% of failed cases had underwent a trial Pavlick harness treatment. Kalamchi and MackEwen score has been used to grade avascular necrosis (AVN). However, no one in the study has developed AVN or stiffness.*

Conclusion: *Our study had an 83.3% success rate. 16.7% was the failure rate. Non of them developed radiographic AVN or stiffness. Pre- reduction IHDH grade IV is highly associated with closed reduction failure. Prior treatment of Pavlick harness is not a determinant factor for failure of closed reduction.*

Keywords
Developmental dysplasia of hip joint, DDH, AVN, Closed reduction, IHDI.

Introduction
Developmental hip dysplasia (DDH) is a generic term describing a spectrum of anatomic abnormalities of the hip that may be congenital or develop during the infancy or childhood [1]. Treatment dep,., ends on the age of the patient and the reducibility of the hip joint. At an early age and up to 6 months, the main treatment is an abduction brace like the Pavlik harness. If this fails, closed reduction and spica casting is usually done. After the age of 18 months, treatment usually consists of open reduction and hip reconstruction surgery [2].

Closed reduction success rates vary. The primary objective of this treatment is to obtain and maintain early concentric and stable reduction of the hip in atraumatic fashion so that the cartilaginous surface of the femoral head is in contact with the cartilaginous floor of the acetabulum, which is important for correcting acetabular dysplasia [3].

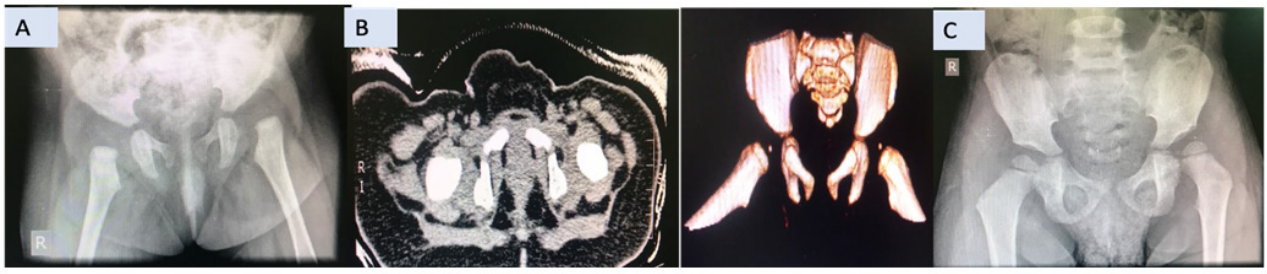
Although close reduction can be a technically easy procedure, it is not benign and requires experience and attention to the detail. Cooper et al. reported a wide variation in failure rate 0-25%, AVN rate 0-14%and re-dislocation rate 2-60% the reported rate of AVN ranges from 4-60% [4].

The objective of this this study is to present the clinical and radiological outcomes of closed reduction in children with DDH in our setting with different follow up periods.

Materials and Methods
Patients Selection
This study was conducted among Omani population who had attended Armed Force Hospital, Muscat in the period between 2010-2020. A retrospective study was performed on 36 hips of 29 patients with developmental dysplasia of hip joint and underwent closed reduction and hip spica cast immobilization followed by abduction splint. 21 patients were affected on one side, 11 patients had left sided DDH while 10 patients had right sided DDH. Number of bilateral DDH cases was 8. All cases were performed by a single operating surgeon.

In this study, demographic data was collected including age, gender, affected side. Pre-operative assessment included physical examination as well as pelvis x-ray (AP view). They were assessed radiographically by using IHDI classification. Data were collected with regard to the outcomes of closed reduction.

At each follow up after closed reduction treatment, they were assessed clinically and radiographically for redislocation, AVN and stiffness. Clinical examination was evaluated using the modified Mckay criteria and radiographic imaging was evaluated using the modified Severin classification. The incidence of AVN



4 months 22 days old baby, diagnosed with bilateral DDH. She was on Pavlic harness treatment. Her left hip joint had treatment failure, so she underwent closed reduction and hip spica application. A. Before closed reduction (IHDI 2) . B. CT images after CR. C. Outcome at 30 months of age with excellent functional and fair radiological outcome (Severin grade 3).

5 months old baby, with left sided DDH. On examination, she had limited left hip abduction, not reducible and positive Galeazzi test. She underwent closed reduction and hip spica application. A. Before closed reduction (IHDI 2). B. After CR. C. Outcome at 12 months of age with excellent functional outcome and fair radiological outcome (Severin grade 3).

was documented and analyzed using Kalamchi and Mckewen score. All children who had DDH as a part of their connective tissue disorder/syndrome or lost to follow up were excluded from the sample of the study.

Statistical analysis

This study was performed using SPSS(SPSS Inc., Chicago, Illinois) for Windows.

Categorical variables are reported as frequency and percentage; continuous variables are presented with a measure of spread (Standard deviation or range).

Results

29 patients underwent Closed reduction and hip spica cast immobilization. Out of 29 patients with DDH, 28 girls and 1 boy were eventually included in the study. 38% of hips were left sided, 34% of hips were right sided, and 28% of patients had bilateral DDH.

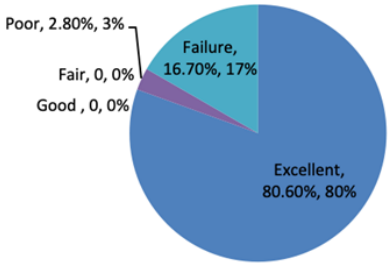
The proportion of hips with a pre-reduction IHDI grade I, II, III, or IV was 8%, 47%, 36% and 8%, respectively. The mean age of DDH patients at the time of closed reduction was 8+/- 4.5 months (range 3- 20 months). Initially, all hips had successful closed reduction. The hips were immobilized in one and half hip spica cast for a total of 12 weeks. Hip spica cast was changed under general anaesthesia at 6 weeks interval.

Clinical and radiographic outcomes were evaluated at each follow up after closed reduction and hip spica cast application. Clinical assessment in the last follow up showed that 81% of hips had excellent outcome, 3% of hips had poor outcome and 17% of hips had treatment failure according to the Mckay scoring system. Radiographic analysis demonstrated that 27.8% had excellent outcome (Severin Class I), 19.4 % had good outcome (Severin Class II), 33.3 % had fair outcome (Severin Class III), and 19.5% had poor results (Severin Class IV to VI).

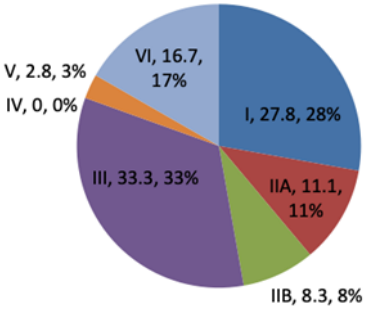
The IHDI grade was higher in those patients who had treatment failure. A significantly higher incidence of re-dislocation was observed in IHDI grade III and IV. The treatment failure was almost 16.6%. The proportions of treatment failure were approximately 31% in patients with a pre-op IHDI grade of III and 67% in patients with an IHDI grade of IV. 50% of failed cases had underwent a trial Pavlick harness treatment. All cases with failed closed reduction underwent successful open reduction, apart from 1 patient who lost follow up. According to the data, a good pre op IHDI grade resulted in better functional and radiographic outcome in all the patients.

To evaluate osteonecrosis of femoral head post-operatively, Kalamchi and MackEwen score has been used. However, no one has developed this complication in this study. In addition, no other post op complications have been recorded such as stiffness.

Functional Results According to Mckay scoring System



Radiological Results According to Severin Classification



Discussion

As one of the primary treatment options for infants with DDH, closed reduction typically includes examination under anesthesia, arthrogram with/without an adductor tenotomy, and postreduction immobilization of the affected hip (eg, spica cast). Although largely successful, closed reduction may also lead to a number of adverse complications, including AVN and loss of reduction [4]. Many studies -were being published- discussed the success rate and possible complications of closed reduction in DDH patients. Tonnis classification was extensively evaluated in those studies as predictor tool for the success of closed reduction in patients with DDH. However, very few studies evaluated the IHDI as a determinant factor for the success of closed reduction. In this study, we wanted to share our experience regarding the outcome of closed reduction treatment in patients with developmental dysplasia of hip joint and to assess the validity of IHDI.

Our main results concerning the use of IHDI system as prognostic factor for closed reduction outcome is similar to those in other publications. Our study had an 83.3% success rate with a 0% incidence of treatment of osteonecrosis and stiffness. Radiographic analysis demonstrated that 27.8% had excellent outcome (Severin Class I), 19.4 % had good outcome (Severin Class II), 33.3 % had fair outcome (Severin Class III), and 19.5% had poor results (Severin Class IV to VI). All the patient in our study with a pre op IHDI grade I or II had excellent outcome. Our finding was almost the same in other studies. The IHDI classification is subjectively more facile to use and has excellent interrelater agreement for

classifying the radiographic severity of DDH. It is also reliable in predicting success of closed reduction [5]. While discussing the outcome of the participants, we found out the failure rate (16.7%) of closed reduction in our DDH patients, which is in the wide range as was reported 0-25% by Cooper et al. (IV).

There are studies with conflicting results regarding the success of closed reduction in patients with failed Pavlik Harness. Although we had limited cases with failed closed reduction, no statistical conclusion could be drawn, implicating that closed reduction treatment will not be successful after failed Pavlik harness treatment, since some cases were preceded with Pavlik harness treatment while others were not.

Many studies have shown that IHDI classification can predict treatment plans. In this study, all patients with a pre-op IHDI grade IV had poor outcome or treatment failure. A larger study sample can confirm this correlation. Besides that, our results showed that IHDI grade IV is associated with poor Severin grade.

Osteonecrosis is one of the most concerning complications following CR. Studies showed the incidence of AVN following CR varies widely between 2% and 36%,with Cooper et al noting that this disparity is "largely caused by differences in the definitions of AVN and the timing of follow-up." Novais et al. reported in their recent meta-analysis an incidence of significant AVN(grade ≥2) of 8% following closed reduction. (IV) Interestingly, our study did not reveal any incidence of avascular necrosis. In addition, the incidence rate of stiffness was also 0%.

Conclusion

Our study had an 83.3% success rate. After initial successful closed reduction, 6 hips had failed reduction and none of them developed radiographic AVN or stiffness. Pre- reduction IHDH grade IV is highly associated with closed reduction failure. Prior treatment of Pavlick harness is not a determinant factor for failure of closed reduction. Further follow-up of this study is necessary to clearly identify the complication rate following closed reduction.

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