Comparison of Radiological Outcome of Open Reduction in Unilateral VS Bilateral DDH

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ABSTRACT

Objective: The purpose of current study is the comparison of the radiological outcome of open reduction in children with unilateral vs bilateral DDH following staged surgery.

Methods: In current study, the medical records of 53 children were retrospectively analyzed, out of which 18 children were with bilateral dysplasia (36 hips) and 35 children were with unilateral dysplasia of hip, all children were treated via staged open reduction with pelvic & femoral osteotomies, operated at Ghurki Trust Teaching Hospital Lahore between August 2020 to July 2022 after taking ethical approval from Hospital Ethical Committee. Patients were followed up to measure the radiological outcome in terms of presence of AVN, subluxation and redislocation of the hip joint. Kalamchi and MacEwen classification and Severin's criteria were used to measure the outcome. Data were entered and analyzed using SPSS software version 27 taking p-value≤.05 as statistically significant.

Results: A total of 53 DDH patients between the ages of 1 to 5yrs underwent open reduction with pelvic and femoral osteotomies. Among these, 35(66.0%) had unilateral DDH, while 18(34.0%) had bilateral DDH. In the bilateral DDH group, the average age of patients at the time of surgery was 3.7yrs while in the unilateral DDH group, it was 3.3 years. More than half of cases 12(66.7%) reported type II or worse AVN as per the classification of Kalamchi and MacEwen in the bilateral group, while less than half 12(34.3%) reported type II or worse AVN in the unilateral group. Radiological evaluation using Severin's criteria revealed that normal appearance was found in 9(50.0%) bilateral and 21(60.0%) unilateral cases. There is statistically significant difference found in radiological outcome between Unilateral and Bilateral DDH groups.

Conclusion: The rate of femoral head osteonecrosis in bilateral DDH patients treated with open reduction is greater than that in unilateral DDH patients at the same hospital having been treated with similar protocols. In the current study, as per the Severin's classification, the radiographic outcome was significantly better in the unilateral hip dysplasia group.

Key Words: Avascular necrosis, Developmental hip dysplasia, Kalamchi and MacEwen classification, Severin's criteria.

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INTRODUCTION

DDH is considered as range of anatomical deformities which affect the hip joint development and stability during growth, ranging from dysplasia of the acetabulum to subluxation or complete femoral head dislocation.[1] The prime objective in the treatment of DDH is to restore the anatomical structures and improve the function of the hip joint. The general

principle is that absolute symmetrical reduction of the femoral head into the acetabulum is a requisite for the treatment of dysplasia of hip.[2]

The incidence of developmental hip dysplasia (DDH) is approximately 1 in every thousand live births, out of which 20% cases are bilateral.[3] According to some authors bilateral DDH has a poor prognosis attributed to the frequent delay in diagnosis because of vague presentation and more requirements in management.[4,5,6,7,8] Some children with bilateral DDH are diagnosed late than unilateral DDH until the children start to walk and have a waddling gait.[9]

Some authors reported poor radiographic outcome in bilateral DDH patients who had to undergo revision surgery after unsuccessful first surgery.[10,11] Some authors have described results of mixed conservative and surgical treatment in both unilateral and bilateral involvement.[12] A study reported by Salter et al. stated that if simultaneous bilateral pelvic osteotomies are performed, it would result in pelvic ring instability and failure of fixation. They recommended the pelvic osteotomy to be performed on the second hip after a gap of two weeks.[13] More treatment requirements, asymmetrical involvement of hips, multiple surgical procedures involved and anatomical variations in bilateral DDH cases play a role in contributing to the poorer outcome in patients with bilateral DDH.[18]

To our information, there is paucity of literature, in which radiological outcome of staged open reduction in patients of unilateral DDH with bilateral DDH has been compared. The current study intended to compare the radiological outcome of unilateral DDH patients with that of bilateral DDH, operated one by one at minimum of 3 months gap, in order to improve our management protocols while treating bilateral DDH patients and to enhance their post-operative outcome. We checked the radiographic outcomes in terms of subluxation, re-dislocation and osteonecrosis following staged surgery.

METHODOLOGY

The current study is single center and retrospective which was conducted at Ghurki Trust Teaching Hospital Lahore, Punjab, Pakistan after taking ethical approval from Hospital Ethical Committee. In the current study, the medical records of DDH patients were reviewed, who were managed with staged open reduction with pelvic and femoral osteotomies from August 2020 to July 2022 at Ghurki Trust Teaching Hospital, Lahore, Punjab, Pakistan. Initially we identified total of 267 patients out of which seventy-four had bilateral and 203 patients had unilateral DDH. Patients having age below 1year and above 5yrs at the time of operation, were excluded. Patients with incomplete record or loss of follow-up, and patients with teratological and neuromuscular DDH were excluded. All patients between the ages of 1 to 5 years, both male and female, with irreducible hip dislocation, both unilateral and bilateral, and in whom no previous intervention had been done, were included in our study. Finally, medical record and follow-up radiographs of 53 patients were reviewed in which 18 patients had bilateral and 35 patients had unilateral developmental hip dysplasia. There were ten boys and twenty five girls in unilateral DDH group, while five boys and thirteen girls in bilateral DDH group. All surgical procedure were performed by a senior surgeon who have expertise and experience in pediatric orthopedic surgery. In all patients open reduction, capsulorrhaphy and pelvic osteotomy with or without femoral shortening was done.

Surgical Technique

All patients were operated under general anesthesia and in supine position with a bolster under the operating side hip. Percutaneous adductor longus tenotomy was performed if the surgeon found it to be tight. Hip joint was approached via the modified Somerville technique. After identifying and protecting the lateral femoral cutaneous nerve, an interval between sartorius and tensor fascia lata was made. The iliac apophysis was longitudinally divided in the midline. Straight head of rectus femoris was divided just distal to anterior inferior iliac spine. Tendon of Iliopsoas was identified with a hemostat and cut near lesser trochanter. Hip joint capsule was released entirely from medially, superiorly and laterally. T-shaped capsulotomy of the hip joint was done and sutures applied for later capsulorrhaphy. Ligamentum teres was cut and followed up to the true acetabulum. Transverse acetabular ligament was also cut. All the fibrofatty tissue was taken out from the true acetabular fossa. If no telescoping was found at the hip joint after reduction, femoral shortening was done at subtrochanteric level using the direct lateral approach. Determination of the amount of shortening was done by the overlap of the two fragments after performing femoral osteotomy and femoral head reduction into the true acetabulum. Femoral osteotomy was internally fixed with dynamic compression plate. Pemberton or Salter pelvic osteotomy was performed depending upon the requirement of acetabular index correction. Graft was

either taken from femoral osteotomy site or from iliac crest, and secured with K-wires. Redundant capsule was excised, and capsulorrhaphy was done after reduction of the femoral head. After wounds closure, one and a half spica cast was given for 6 weeks post-operatively, with the hip in 45°-60° of flexion, 45°-60° of abduction and up to 15° of internal rotation. K-wires were removed at 6 weeks and spica cast was reapplied for another 6 weeks. After the removal of spica, non-weight-bearing exercises were started and gradual unrestricted activities were allowed after the radiological signs of healing (callous formation seen on radiographs). In Bilateral DDH patients, only single hip was operated at one time with three to six months interval for the other hip corrective surgery. Hip with higher Tonnis grading was operated first. In both groups, the mean follow-up duration was 9 months. Final follow-up antero-posterior (AP) pelvic radiographs were evaluated and classified by two independent observers for acetabular indices (A.I), presence or absence of AVN of femur head as per Kalamchi-MacEwen classification (Table-II), and subluxation or re-dislocation of femur head with the help of Severin's classification (Table-I).

Table I: Severin's classification for assessment of post-operative radiographic outcome[11]

Class	Definition
I	Normal appearance of hip joint
II	Mildly deformed femoral head, neck or acetabulum
III	Hip dysplasia or moderately deformed femoral head, neck or acetabulum; or both
IV	Subluxation of femoral head
V	Femoral head articulating with false acetabulum
VI	Re-dislocation
VII	Arthritic

Table II: Kalamchi and MacEwen's Classification for Osteonecrosis of the femoral head[14]

Grade	Description
I	Ossific nucleus mottling and revascularization. Complete resolution in long term
II	Epiphysis and lateral physis involved, resulting in coxa valga, Minimum leg length discrepancy
III	Epiphysis and central physis involved, resulting in coxa vara
IV	Total involvement of femoral head and physis resulting in Osteoarthritis and leg length discrepancy

RESULTS

Total 53 DDH patients with range of ages from 1 to 5 years underwent open reduction and pelvic & femoral osteotomies. Among these, 35(66.0%) had unilateral DDH, while 18(34.0%) had bilateral DDH. In the Unilateral group, 25 (71.4%) were female, while 10(28.6%) were male with an average age of 3.37±1.54 ranging from 1 to 5 years. While in bilateral group, females were 13 (72.2%), and males were 5(27.8%) with average age 3.93±1.1 ranged from 2 to 5 years. In the unilateral group, 57.1% had left DDH, and 42.9% had right DDH. Clinical investigational data of the patients is described in Table-III.

Table III: Demographic data of study patients

Patient characteristics	Unilateral (n=35)	Bilateral (n=18)	p-value
Females	25(71.4)	13(72.2)	0.952
Males	10(28.6)	5(27.8)	
Age at surgery (mean ± SD) Range	3.37±1.54 (1-5)	3.72±1.32 (1-5)	0.416
Left side	20(57.1)		
Right side	15(42.9)		

The findings obtained statistically significant results based on the radiological outcome regarding Severin and Kalamchi criteria as $p<0.05$. The rate of the severity of AVN was quite higher in the bilateral DDH group than unilateral group. More than half of cases 12(66.7%) reported type II or worse AVN in the bilateral group while less than half 12(34.3%) reported type II or worse AVN in the unilateral group

(Table IV). Radiological evaluation using Severin's criteria reveals that normal appearance was found in 9(50.0%) bilateral and 21(60.0%) unilateral cases, so, the unilateral group provided a better radiological outcome than the bilateral group. In unilateral group, the mean acetabular index was 13.14°±5.69°, slightly lower than the bilateral group (Left=15.07°±6.62°; Right=15.66°±6.62°), and the difference in the mean acetabular index between the two groups is statistically insignificant. At follow-up, the mean center edge angle was 31.34° (range= 11°-56.9°) in the unilateral group, slightly lower than the bilateral which was 35.51° (range= 14°-61°) on the left side and 33.05° (range= 6°-59.5°) on the right side. In the bilateral group, one patient had right sided dislocated hip and one patient had subluxated left hip compared to unilateral where two patients reported post operative hip subluxation.

Table IV: Comparison of Clinical and Radiological evaluation between Unilateral & Bilateral

Parameters	Categories	Bilateral	Unilateral	P-value
Acetabular index. (mean±SD); Range	Left	15.07°±6.62° (5.6°-30.4°)	13.14°±5.69° (0°-25.3°)	>.05
	Right	15.66°±6.62° (5.9°-28.05°)		
Kalamachi – MacEwen Classification N (%)	Grade I	3	9	<.001
	Grade II	6	1	
	Grade III	6	-	
	Grade IV	-	2	
	Normal	3	23	
Severin's criteria N (%)	Grade I	9	21	*.0187
	Grade II	5	8	
	Grade III	-	3	
	Grade IV	4	3	
Center-Edge Angle (mean±SD); Range	**Left**	35.51°±12.21° (14°-63°)	31.34°±11.05° (11°-56.9°)	>.05
	Right	33.05°±13.17° (6°-59.5°)		

**p≤.05; statistically significant

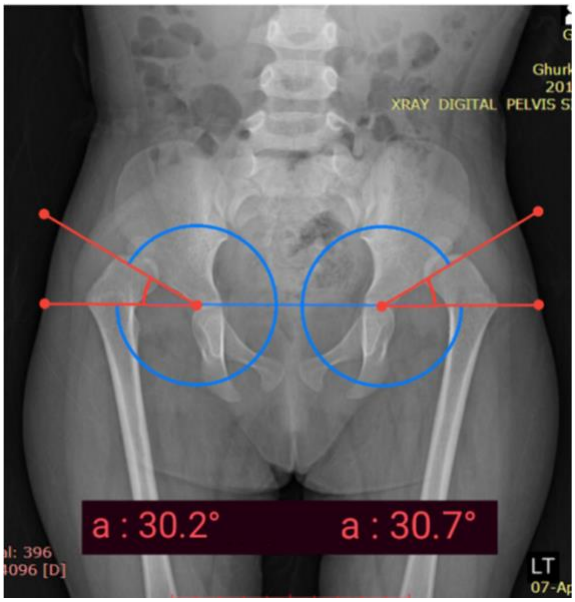

Fig. 1: 4 years old female patient

Preoperative radiograph showing bilateral DDH Tonnis grade IV

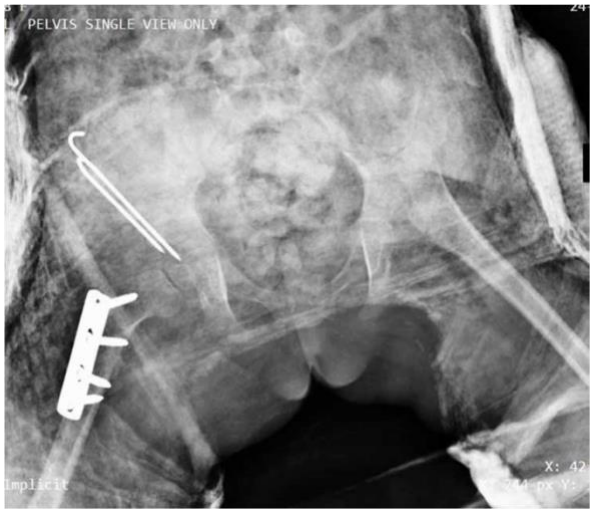

Fig. 2: immediate post-operative radiograph

Fig. 3: 1 year post-operative follow-up radiograph of left hip; and 1 year and 4 months post-operative follow-up of right hip, presenting normal grade according to Kalamchi-MacEwen's classification.

DISCUSSION

There is a common opinion that DDH diagnosis in early phases leads to good treatment outcomes and low risk of complications.[15,16] The prime principle in the treatment of developmental hip dysplasia in a child is concentric reduction of head of femur into the true acetabulum and to achieve good functional outcome. An unreduced hip can lead to painful and restricted range of motion of the hip joint, abnormality in gait pattern and early hip joint arthritis.[10] Contrary to unilateral developmental dysplasia of hip, patients with bilateral DDH have drastic outcome with more risk of failure and less chances of correction of acetabular dysplasia in symmetrical manner.[17]

In a study reported by Wang et al., 56 bilateral DDH patients were compared with 156 patients with unilateral DDH. They stated 80.4% satisfactory results in bilateral cases and 86.5% in unilateral DDH patients with respect to Severin's criteria. Moreover, they reported in their study that in bilateral DDH patients there was 55% type II or worse osteonecrosis while in unilateral DDH cases it was 38% type II or worse femoral head osteonecrosis as per the Kalamchi and MacEwen's classification. Although the difference between the two DDH groups as per the Severin's classification was insignificant, but according to them the unilateral DDH cases had better outcome as per the Kalamchi and MacEwen's classification.[4]

Greene and Drennan showed the opposite conclusion in their comparative study in 1982. According to them, the unilateral DDH patients had a higher rate of incidence of femoral head osteonecrosis than the bilateral DDH patients.[12] Klisic and Jankovic reported that out of 60 hips operated, result of the 3% came out to be excellent, 60% result to be good, 30% result to be fair while poor in 7% of the cases. However, the authors did not mention the method used for evaluation of femoral head osteonecrosis.[16] Thomas and Salter in their study reported bilateral DDH cases had at significantly higher risk of failure and subsequent hip joint replacement as compared to unilateral DDH cases.[17] Asymmetric outcome after open reduction is a complication that may cause poor radiological and clinical outcomes. Factors playing role in this regard are anatomical variations, dissimilar grade of dislocation and successive surgical procedures on both hips.[18] In bilateral DDH patients, we selected the worse side as the reference hip for comparison with unilateral patients, if the outcome was not symmetrical.

Our study results showed that the rate of the severity of AVN was significantly higher in bilateral DDH group in comparison to unilateral DDH group. Radiological evaluation according to the Severin's criteria revealed that unilateral DDH group provided a better radiological outcome. In literature, the re-dislocation rate after open reduction of DDH has been quoted as 0% to 8%.[8] Our analysis also showed a higher re-dislocation rate in bilateral DDH patients, although it is statistically insignificant because of the small number of study population. In our opinion more treatment requirements, asymmetrical involvement, anatomical variations, multiple surgical procedures and the factors of safeguarding the previously operated side while doing surgery on the other hip, all contribute to the relative poorer outcome in bilateral DDH cases than the unilaterally involved cases. This is a retrospective study conducted at a single center with a relatively small number of patients and duration of follow-up was also short. Further studies with larger number of patients and longer follow-up duration are needed to confirm current study results.

CONCLUSION

The current study results showed that the rate of femoral head osteonecrosis in bilateral DDH cases treated with open reduction is greater when compared to unilateral DDH cases. There was statistically significant difference found between unilateral and bilateral DDH cases according to Severin's classification as the unilateral

developmental hip dysplasia cases showed better radiographic outcome.

Conflict of Interest: None

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