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Evaluation of Radiological Outcomes Following Open Reduction and Pemberton's Procedure for Pediatric Developmental Dysplasia of Hip

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ABSTRACT

Background: Surgical management is indicated in paediatric patients with developmental dysplasia of the hip with late presentation or failure of nonsurgical care. The goal of surgery is to achieve a stable reduction to facilitate femoral head and acetabulum growth while preventing femoral head osteonecrosis and the need for further surgery. The Pemberton's procedure for Developmental dysplasia (DDH) of the hip can be a safe and successful method in the treatment of developmental hip dysplasia in older children. The present study was carried out with an objective to assess the radiological outcomes following Pemberton's procedure.

Methods: A retrospective study was carried out in a tertiary care centre from 2007-2011. About 70 patients with 88 hips who underwent open reduction and Pemberton's procedure were included in the study. Radiological follow-up was done with X-ray to assess Acetabular index (AI), Shenton's line (SL), and any signs of early avascular necrosis (AVN) of head of the femur. Data of the radiological indices were entered in excel and analyzed in SPSS 23. Mean, percentages, and appropriate statistical tests such as paired t-test and Kappa Coefficient were applied.

Results: In final 70 patients selected in the study, 57 (81.4%) were females and 13 (18.6%) were males. The AI outcome was studied in the patients for the right and left hip where 94.9%-97.7% within 6 months post-surgery and 92.3% at 2 years post-surgery were converted from abnormal to normal status. SL outcome was studied for the right and left hip where 88.1%-86.1% within 6 months post-surgery and 95.2%-97.7% at 2 years post-surgery were converted from broken to intact status. AVN outcome at 2 years post-surgery for the right and left hip which results 81.1% - 83.3%.

Conclusion: The pediatric patients diagnosed with DDH who underwent open reduction and acetabuloplasty using Pemberton's procedure has shown significant improvement in the studied radiological orthopedic outcomes.

Key words: Developmental dysplasia of hip, Pemberton's procedure, Open reduction, Radiological assessment

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INTRODUCTION

Developmental dysplasia of the hip (DDH) is one of the most common problems in pediatric orthopedics in Saudi Arabia. DDH represents a spectrum of conditions that range from a simple neonatal instability to an established dislocation. Due to the lack of screening programs in Saudi Arabia, there is a high incidence of DDH. In Saudi Arabia, the prevalence of DDH is quite common but not documented statistically yet. On the other hand, in the developing countries where early diagnosis is not of much practice untreated cases complicated with time and require operative treatment.

The normal hip is a stable ball and socket joint acetabulum in which the head of the femur (ball) articulates with the acetabulum (socket). Development dysplasia of the hip (DDH) refers to a clinical condition of abnormal relation of femoral head and acetabulum [1]. It is described as a group of conditions where the acetabulum is shallow and dysplastic, subluxation and possible dislocation of the hip secondary to capsular

laxity hip wear out leading to osteoarthritis, the commonest cause of total hip replacement. High rate of success and the minimal risk involved in treatment attract practitioners to do early screening and detection of an early sign of a hip disorder. There is no doubt that open reduction and capsulorrhaphy with or without femoral shortening can relocate the head but there is always the scope of reorientation of the acetabulum to improve head coverage and acetabular index [2-8].

OBJECTIVES

This study seeks to evaluate radiological outcomes in paediatric patients with DDH following the open reduction and acetabuloplasty using Pemberton's procedure.

METHOD

This retrospective observational study was carried out in King Fahad Medical City Riyadh, Saudi Arabia, to assess the radiological parameters for those the patients following the open reduction and acetabuloplasty by using Pemberton's procedure, which are acetabular index, Shenton's line, graft dislodgment, and avascular necrosis. For acetabular index and Shenton's line and, we took it before, after surgery within 6 months, and after follow up for 2 years. Whereas graft dislodgment and avascular necrosis, the measurements were taken after follow-up for 2 years. All measurements are taken from AP Pelvis X-ray. 250 patients are targeted, treated, and followed up on our centre from (2007- 2011). Ethical approval was obtained from King Fahad Medical City, Ministry of Health, Saudi Arabia with IRB No. 13-100.

We found the total number of patient those have DDH and underwent hip open reduction and Pemberton's acetabuloplasty +/- femoral shortening is 179 patients (209 hips). We made the age limit 16 months – 6 years of the age, including unilateral or bilateral DDH. All patients underwent open reduction, adductor tenotomy, capsulorrhaphy, Pemberton's acetabuloplasty with or without femoral shortening with minimal follow up for all patients 2 years. We excluded 96 patients (106 hips) those are not following up in the clinic for ≥2 years. The remnant 83 patients (103 hips). Then we excluded 2 patients (3 hips) those their age during the procedure one above 72 months and the other is less than 16 months. The remnant 81 patients (101 hips). Then we excluded 3 patients (3 hips) those are operated before for open reduction. The remnant 78 patients (98 hips). Then we excluded 8 patients (10 hips) those have systemic or teratologic disorders 3 patients with cerebral palsy (one associated with hydrocephalus), 2 patients with spina bifida , one patient with arthrogryposis, one patient with Fanconi anaemia and one patient with cretinism & hypothyroidism .The remnant 70 patients (88 hips) as the total number of our sample those involved in our study. All necessary data regarding the age and the sex of patients were taken from PACS. We collected the data randomly from the electronic system for radiological images for all patients (PACS). Most care was taken in moulding the posterolateral aspect of the hip region", and consider something like this "All patient underwent anterior approach to the hip followed by the attainment of concentric reduction and placement of capsulorrhaphy sutures, which were tied after the completion of the pelvic osteotomy as described by Pemberton28. One and a half spica after surgery with the hip in 30° flexion, approximately 20° of internal rotation and 20-30° of abduction for 12 weeks, with one change at 6 weeks under general anaesthesia (GA). All the cases were monitored by senior surgeon strictly in all cases of postoperative spica application to ensure maintenance of reduction and utmost care was taken in moulding the posterolateral aspect of the hip region. All the patients were followed up for minimum 2 years.

All patients after surgery underwent post-operative care which includes Hip Spica for 6 weeks then Broomstick cast for another 2-6 weeks. If K. wire was inserted to maintain reduction, will be removed after the change of Hip Spica to broomstick cast.

Outcome measures: The radiological parameters

- ✓ Acetabular Index (AI, classified as “normal” if the score was < 30 otherwise was considered “abnormal”).
- ✓ Shenton's Line (SL, “broken” or “intact”).
- ✓ Graft Dislodgment (GD).
- ✓ Avascular Necrosis (AVN) classified as 0, 1, 2, 3, or 4) as per Kalamchi classification [9].

RESULTS

The present study entitled, "Evaluation of Radiological Outcomes Following open reduction & Pemberton's Procedure for Paediatric DDH was an effort to study the common radiological manifestations after six months and 2 years of surgery where 70 patients including 88 hips were considered. Out of the 70 patients, 57 (81.4%) were females and 13 (18.6%) were males. The mean age of the patients was 26.1 + 12.2 Months, which was 27.3 months for females and 23.1 months for males and it ranges. From 18 – 49 months. Results of the study are summarized in Table 1.

Out of the total studied population 16(22.9%) patients had bilateral hip surgery; 27(38.6%) patients had (only) right hip surgery, 27(38.6%) had (only) left Hip surgery; 60(85.7%) patients were without femoral shortening; 4(5.7%) patients had bilateral femoral shortening, 4(5.7%) patients had (only) left femoral shortening and 2(2.9%) patients were with (only) right femoral shortening. Results of the study are summarized in Table 2.

The AI outcome was studied in the patients for the right and left hip where 94.9%-97.7% within 6 months post-surgery and 92.3% at 2 years post-surgery were converted from abnormal to Normal status (p-values < .0001). Similarly, SL outcome was studied for the right and left hip where 88.1% - 86.1% within 6 months post-surgery and 95.2% - 97.7% at 2 years post-surgery were converted from broken to intact status (p-values < .0001). AVN outcome at 2 years post-surgery for the right and left hip which results 81.1% - 83.3% classified as having "0" or "1" scores. None of these outcomes differed significantly by femoral shortening status. Results are shown in Table 3 and Table 4. Kappa coefficient analysis found that hip joint distance may be associated with residual acetabular dysplasia (AI) and Shenton's Line during growth (Table 3 and Table 4).

#For the outcome AI, overall (for the right and left hip), improvement from abnormal to normal; ##For SL outcome and for the right and left hip, overall, those who converted from "broken" to "intact" status; ###For AVN outcome in terms of no Graft Dislodgment (GD) incidence at 6 months and 2 years post-surgery and overall, (for the right and left hip).

DISCUSSION

The present study is directed to evaluate the radiographic outcomes of the DDH pediatric patients following open reduction and Pemberton's acetabuloplasty with or without femoral shortening, unilateral or bilateral DDH with a minimal follow up 2 years.

In case of delayed diagnosis or untreated in early infancy, DDH treatment requires open reduction, which enables direct access to the main obstacle to concentric reduction, such as tight iliopsoas tendon, inferomedial joint capsule and hypertrophied pulvinar [8-15]. In the present study a total of 88 hips (70 patients) were chosen. The paediatric patients diagnosed with DDH, and underwent open reduction and acetabuloplasty using Pemberton's procedure, were of an age group of 16 months to 6 years,

Table 1: Distribution of patients based on sex and age.

Patients	Sample		Age	
	Size	Percentage	Average	Range
Male	13	18.6	23.1	21–35
Female	57	81.4	27.3	18–49
Total	70	100	26.1	18–49

Table 2: Distribution of DDH patients based on surgical procedure.

Manifestation	Patients	
	Size	Percentage
Bilateral hip surgery	16	22.9
Only Right hip surgery	27	38.6
Only left hip surgery	27	38.6
Femoral shortening	60	85.7
Bilateral Femoral shortening	4	5.7
Only Right femoral shortening	4	5.7
Only left femoral shortening	2	2.9

Table 3: Status of radiographic AVN for all hips before surgery, and after 6 months and 2 years of surgery.

Variables	AVN Present (Percentage)			AVN Absent (Percentage)			Kappa Coefficient	95% lower confidence limit	95% Upper confidence limit
	Before	After 6 months	After 2 yrs	Before	After 6 months	After 2 yrs			
Shenton's Line (RT)	92.11	12.7	3.4	7.89	87.3	96.6	0.0023	-0.0032	0.0079
Shenton's Line (LT)	84.26	13.9	2.1	15.74	86.1	97.9	0.0017	-0.0031	0.0065
Acetabular Index (RT)	86.84	7.7	1.2	92.3	96.9	98.8	0.0153	-0.0073	0.0379
Acetabular Index (LT)	62.5	9.9	1.3	37.5	90.1	98.7	-0.0394	-0.1335	0.0547
No femoral shortening (RT)	8.9	79.9	80.95	91.1	20.1	19.05	-	-	-
No femoral shortening (LT)	12.2	78.5	82.22	87.8	21.5	17.78	-	-	-

Table 4: Evaluation of AI, SL and AVN incidences after six months and 2 years of operations.

Evaluation	Postoperative Measurements	Male	Female	Mean	P-value
AI#	6 months postoperative	91.9	93	92.3	<0.001
	2 years postoperative	95.7	97.3	96.9	<0.001
SL##	6 months postoperative	87.1	87.4	87.3	<0.001
	2 years postoperative	98.1	96.1	96.6	<0.001
AVN###	6 months postoperative (0 – 1)	82.1	82.4	82.2	<0.001
	2 years postoperative (0 – 1)	100	100	100	<0.001

with an average value of 26.1 ± 12.2 months. Out of the total cases 81.4% female.

There is always a risk of avascular necrosis involved in the treatment of developmental dysplasia of hip which ranges to 50% of total operative cases. Some recent studies suggested that the chances of avascular necrosis are not exceptionally low in open reduction and acetabuloplasty using Pemberton's procedure. Thus to avoid such chances a great care was taken during the surgery.

In high dislocation, the anatomy is markedly distorted by the soft tissue contracture, inadequate bone stock, abnormal location of the hip centre, abnormality of the neurovascular structures, and leg length discrepancies. With these abnormalities, it is difficult to achieve and maintain reduction in the true acetabulum. Subtrochanteric femoral osteotomy and shortening is one approach that makes reduction easier [16-23].

Since a significant population in our study was of older patients (>3 years) and instability of hips was large so femoral shortening osteotomies was performed. Out of 70 patients 60% were operated without femoral shortening, 5.7% with bilateral femoral shortening, 5.7% with only left femoral shortening and 2.9% with only right femoral shortening.

Also the femoral shortening makes reduction easier but can be associated with complications (e.g., limp, sciatic nerve injury, non-union of the osteotomy) or compromise the long-term survival of the stem. We therefore evaluated the rate of short-term complications in patients with high DDH reconstructed with femoral shortening.

The outcome of the study was evaluated by acetabular index (where <30 was treated as normal and >30 considered abnormal) and Shelton's line (broken or intact). These radiological parameters were determined before, after 6 month and after 2 years of surgery. Also Graft dislodgement and Avascular necrosis using Kalamchi and MacEwin's Classification were measured 2-year post surgery [24]. Paediatric patients diagnosed with DDH who underwent open reduction and acetabuloplasty using Pemberton's procedure as shown significant improvement in these radiological outcomes.

A break in Shenton's line suggests displacement of the femoral head from the bony acetabulum. The status of SL for the right and left hip within 6 month post-surgery was 86.1 to 81.1% whereas it was found to be 95.2% 97.7% after 2 years of surgery. Thus, the overall SL score was acceptably good.

Acetabular index is another useful measurement, formed by the junction of Hilgenreiner's and a line drawn along the acetabular surface. In normal newborn, the acetabular index averages 27.5 degrees, at six months 23.5 degrees and at two years, 20 degrees. Thirty degrees is considered the upper limit of normal. It was found that 92.3 percent cases were improved from abnormal to normal within 6 months of surgery and 94.9 percent to 97.7% return to normal at 2 years post-surgery [25-26].

The AVN score 2 years post-surgery for the right and left hip was found to be very low and classified as 0 and 1. Thus our work was not in compliance with some of the recent studies which have reported that the chances of avascular necrosis are high in case of medial open reduction and nearly similar to those in anterolateral open reduction [9,27].

CONCLUSION

The normal development of the child's hip relies on congruent stability of the femoral head within the acetabulum. In DDH with high dislocation, the anatomy is markedly distorted by the soft tissue contracture, inadequate bone stock, abnormal location of the hip centre, abnormality of the neurovascular structures, and leg length discrepancies. With these abnormalities, it is difficult to achieve and maintain reduction in the true acetabulum. Early diagnosis and treatment of DDH is critical to provide the best possible functional outcome. The acetabular changes in DDH are well recognized. Recently we also gained understanding into the changes of the femoral head. The traditional risk factors for DDH were questioned and new ones were explored, and consequently we have a better understanding of the factors that are associated with this condition. Despite best efforts many young adults with dysplasia are not detected at birth. And in the older age children (>2 yrs.) the instability of hip becomes high and generally requires operative interventions. Open reduction is a treatment of choice with minimum failure record if utmost care is taken into account. In the present study paediatric patients diagnosed with DDH who underwent open reduction and acetabuloplasty using Pemberton's procedure has shown significant improvement in the studied radiological orthopaedic outcomes.

CONFLICT OF INTEREST

None.

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REFERENCES

1. Argenson JN, Flecher X, Parratte S, et al. Anatomy of the dysplastic hip and consequences for total hip arthroplasty. Clin Orthop Relat Res 2007; 465:40–45.
2. Millis MB, Zaltz I. Current perspectives on the pediatric hip: Selected topics in hip dysplasia, Perthes disease, and chondrolysis: Synopsis of the hip subspecialty session at the POSNA Annual Meeting, May 1, 2013, Toronto. J Pediatr Orthop 2014; 34:S36–S43.
3. Sosna A, Rejholec M. Ludloff's open reduction of the hip: Long-term results. J Pediatr Orthop 1992; 12:603–606.
4. Koizumi W, Moriya H, Tsuchiya K, et al. Ludloff's medial approach for open reduction of congenital dislocation of the hip. A 20-year follow-up. J Bone Joint Surg Br 1996; 78:924–929.
5. Morcuende JA, Meyer MD, Dolan LA, et al. Long-term outcome after open reduction through an anteromedial approach for congenital dislocation of the hip. J Bone Joint Surg Am 1997; 79:810–817.
6. Ucar DH, Isiklar ZU, Stanitski CL, et al. Open reduction through a medial approach in developmental dislocation of the hip: A follow-up study to skeletal maturity. J Pediatr Orthop 2004; 24:493–500.
7. Bulut O, Oztürk H, Tezeren G, Bulut S. Arthroscopic-assisted surgical treatment for developmental dislocation of the hip. Arthroscopy 2005; 21:574–579.
8. Ferguson AB. Primary open reduction of congenital dislocation of the hip using a median adductor approach. J Bone Joint Surg Am 1973; 55:671–689.
9. Hoellwarth JS, Kim YJ, Millis MB, et al. Medial versus anterior open reduction for developmental hip dislocation in age-matched patients. J Pediatr Orthop 2015; 35:50–56.
10. Konigsberg DE, Karol LA, Colby S, et al. Results of medial open reduction of the hip in infants with developmental dislocation of the hip. J Pediatr Orthop 2003; 23:1–9.
11. Baki C, Sener M, Aydin H, et al. Single-stage open reduction through a medial approach and innominate osteotomy in developmental dysplasia of the hip. J Bone Joint Surg Br 2005; 87:380–383.
12. Citlak A, Saruhan S, Baki C. Long-term outcome of medial open reduction in developmental dysplasia of hip. Arch Orthop Trauma Surg 2013; 133:1203–1209.
13. Okano K, Yamada K, Takahashi K, et al. Long-term outcome of Ludloff's medial approach for open reduction of developmental dislocation of the hip in relation to the age at operation. Int Orthop 2009; 33:1391–1396.
14. Koizumi W, Moriya H, Tsuchiya K, et al. Ludloff's medial approach for open reduction of congenital dislocation of the hip. A 20-year follow-up. J Bone Joint Surg Br 1996; 78:924–929.
15. Altay M, Demirkale I, Senturk F, et al. Results of medial open reduction of developmental dysplasia of the hip with regard to walking age. J Pediatr Orthop B 2013; 22:36–41.
16. Tarassoli P, Gargan MF, Atherton WG, et al. The medial approach for the treatment of children with developmental dysplasia of the hip. Bone Joint J 2014; 96:406–413.
17. Hoellwarth JS, Kim YJ, Millis MB, et al. Medial versus

anterior open reduction for developmental hip dislocation in age-matched patients. J Pediatr Orthop 2015; 35:50–56.

18. Bruce WJ, Rizkallah SM, Kwon YM, et al. A new technique of subtrochanteric shortening in total hip arthroplasty: surgical technique and results of 9 cases. J Arthroplasty 2000; 15:617–626.
19. Erdemli B, Yilmaz C, Atalar H, et al. Total hip arthroplasty in developmental high dislocation of the hip. J Arthroplasty 2005; 20:1021–1028.
20. Eskelinen A, Helenius I, Remes V, et al. Cementless total hip arthroplasty in patients with high congenital hip dislocation. J Bone Joint Surg Am 2006; 88:80–91.
21. Kim YH, Seo HS, Kim JS. Outcomes after THA in patients with high hip dislocation after childhood sepsis. Clin Orthop Relat Res 2009; 467:2371–2378.
22. Koulouvaris P, Stafylas K, Sculco T, et al. Distal femoral shortening in total hip arthroplasty for complex primary hip reconstruction: A new surgical technique. J Arthroplasty 2008; 23:992–998.
23. Krych AJ, Howard JL, Trousdale RT, et al. Total hip arthroplasty with shortening subtrochanteric osteotomy in Crowe type-IV developmental dysplasia. J Bone Joint Surg Am 2009; 91:2213–2221.
24. Kalamchi A, MacEwen GD. Avascular necrosis following treatment of congenital dislocation of the hip. JBJS 1980; 62:876-888.
25. Hensinger RN. Standards in Pediatric Orthopedics. New York: Raven Press 1986.
26. Laurenson RD. The acetabular index: A critical review. J Bone Joint Surg Br 1959; 41:702–710.
27. Tarassoli P, Gargan MF, Atherton WG, et al. The medial approach for the treatment of children with developmental dysplasia of the hip. Bone Joint J 2014; 96:406–413.