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Functional Outcome after Revision Surgery for Developmental Dysplasia of the Hip (DDH)

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Abstract

Background: Failure after primary DDH surgery can occur early or immediate, delayed (within six months) and late due to poor remodelling. We report the short-term results after revision surgery in eighteen children including four early and 14 delayed failures.

Patient and Methods: Between 2002 and 2017, eighteen children (19 hips) underwent primary surgery at a mean age of 19 months (range: 9 months – 24 months). There were 12 girls and 6 boys in the study, with nine left and eight right sided dislocations. One child had bilateral dislocation. The mean age at revision surgery was 30 months (range: 22 months – 48 months).

Results: All cases were assessed with the modified Ponseti score to include squatting and cross-leg sitting. Eleven children (61%) were completely pain free, able to squat (Modified Ponseti score 1 and 2), three (17%) had mild limp and four (22%) had gross limitation of function. Avascular necrosis (AVN) was recorded according to Kalamchi and MacEwen criteria. Nine hips (50%) had mild AVN and six (33%) had coxa valga due to lateral physeal arrest.

The radiological outcome at final radiograph was based on Severin grade. Only 4 hips (22%) had a spherical head. Ten hips had moderate deformity (55%) and 5 hips (27%) had aspherical incongruency.

Conclusion: Early and delayed failures in DDH surgery are mainly due to inadequate initial exposure and poor hip stabilization techniques. About 50% of the revision cases had a satisfactory outcome on short term follow-up.

Keywords: Hip, Revision, Surgery, Function, Outcome

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Background

Repeat surgical intervention after failure of primary surgery for developmental dysplasia of hip (DDH) surgery is both complex and tests the surgeon's skills [1, 2, 3]. The incidence of re-dislocation and failure after initial surgery varies from 3 percent – 15 percent [4, 5]. Several authors have emphasized the technical reasons for failure – insufficient exposure of the acetabulum, poor capsular repair, concomitant femoral and pelvic osteotomy, and inadequate spica cast application and care [2, 3, 6, 7, 8].

The outcomes after revision DDH surgery are never as satisfactory as the initial attempt at successful concentric reduction [2, 3, 8, 9, 10, 11]. The risk of avascular necrosis and growth disturbance can affect the femoral head morphology and acetabular remodeling [11, 12, 13].

The aim of our study is to retrospectively analyze the temporal occurrence of failure and report the clinical and radiological outcome in 18 patients who underwent revision hip surgery.

Patients and Methods

Between 2004 and 2019, twenty-two children underwent revision DDH surgery after an unsuccessful primary open reduction. Eighteen patients (19 hips) who had complete records were available for final assessment. There were 12 girls and six boys

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Figure 1: Right hip re-dislocation after spica removal following open reduction, femoral derotation osteotomy and Dega procedure.

Figure 2: Revision surgery was performed and with repeat femur osteotomy.

in the study. Only children with idiopathic DDH that had failure of their index procedure to enlocate the hip after open reduction with or without a concomitant bony procedure were included. We excluded neuromuscular, teratological and syndromic dislocations. Two children in the study had undergone a revision procedure previously after failure of initial open reduction and were included in the study.

The primary surgery for DDH was as follows:

12 children underwent open reduction (OR) only, 3 had additional varus osteotomy (VO), two had OR with a Salter's procedure and one child underwent OR with VO and a Dega procedure. Adductor tenotomy was performed in 14 cases.

The mean range of hip motion (ROM) was 80^0 flexion (10^0 – 130^0), 30^0 abduction (5^0 – 60^0), 20 degrees (0-45 degrees) of rotation. Sixteeen children were able to squat with some support, and two children that underwent one revision surgery each, had limitation of hip ROM: one child had abduction deformity and the other child had restricted abduction and rotation which lead to difficulty in squatting and sitting cross-legged.

All children had painless ROM but walked with a limp and an external foot progression angle. The mean limb length discrepancy was 0.7 cm (0-1.5). All children had well healed scars but the location of scar for primary surgery was suboptimal in four children. Two children had a lateral incision, one child had an anterior longitudinal incision parallel to the femoral nerve and in the fourth child, a posterior approach had been used. In three of these four children the hip had never been reduced in the native acetabulum.

Surgical tips and challenges in revision DDH surgery:

General anesthesia with lumbar epidural infusion was used in all children to maintain a hypotensive field as the scar tissue can profusely bleed during revision surgery.

Figure 3: Follow up at 3 years shows the head is well located and the proximal femur varus has remodeled.

Figure 4: Final follow up at 5 years shows that child is able to squat, there is no limb length discrepancy. The modified Ponseti score was 1.

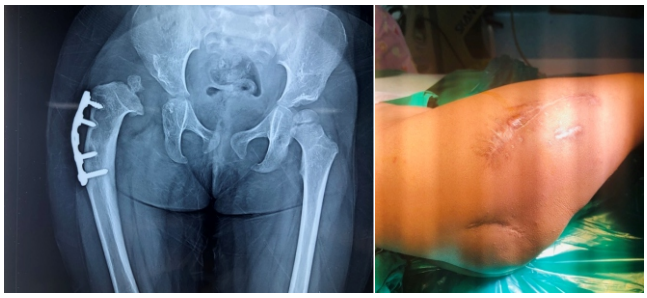

Figure 5&6: Radiograph and surgical approach for the index surgery. The surgeon had approached the hip from the lateral side. The radiograph revealed that the hip was not seated in the native acetabulum.

Figure 7&8: Post-operative radiograph after VDRO, shortening and Salter Procedure. At six months she is able to partially squat and walk with slight limp.

A modified Smith-Peterson approach was used in all revisions across any previous incisions to get optimal exposure to the hip. The lateral cutaneous nerve was seen and protected in 15 cases and in three cases the nerve could not be located.

In the four children where the previous surgical incision had been poorly placed it was easy to locate the muscle planes and identify the capsule. In the remaining 14 children, there was considerable scarring of the muscle planes. The iliac apophysis was split in all cases and dissection was carried along the lateral iliac wall to clear the pseudo-capsule up to the level of true acetabulum. One of the challenges in revision surgery is to identify the capsular extent from the surrounding adherent scar tissue. A technique developed by the first author called "saline distension", which helps define the limit of the capsular distension from surrounding fibrotic tissue, was used. Approximately, two-to-three milliliters of normal saline was injected medially through the fibrotic capsule and the syringe was held in place to prevent back flow. As the capsule expanded, its entire extent from medial to lateral, and superior to inferior, could be visualized. This procedure facilitated clearance of soft tissue over the taut capsule with the help of electrocautery. In 5 cases the intact psoas tendon was incised, but in cases where it had been previously cut, the tendon had reformed as a fibrous tether. This fibrous band had to be distinguished from the femoral nerve and then released to see the medial capsular extent. The ligamentum teres (LT) was present in four cases and in the remaining cases it had sheared off its foveal attachment on the femoral head. After the capsular was incised, intra-articular adhesions and scar tissue covering the true acetabulum were carefully excised. Intra-operative imaging was helpful to locate the extent of the true acetabulum. Dissection was carried out inferiorly to remove remnants of the LT and transverse acetabular ligament (TAL). A straight and angled disc forceps used for spine surgery with its blunt ends is a useful instrument to clear intra-acetabular adhesions. In the 2 cases that had undergone previous revision surgery, there was a sheet of scar tissue in the inferior part of the socket. This was meticulously removed with intermittent bipolar cautery and disc forceps to expose the true acetabulum. Of the eighteen hips, 4 hips could be reduced without any soft tissue tension on the femoral head. Of these 4 hips, three hips were stable with 30 degrees abduction and 30 degrees flexion hence underwent a Salter's procedure and one hip was stable in the neutral walking position (5-10 degrees of flexion, 10 degrees of abduction).

In fourteen cases, a VDO with shortening was required to secure the head into the socket due to excessive soft tissue tension. The mean shortening performed was 1.5 cm (1 – 3 cm). In addition to the VDO and shortening, a pelvic procedure was added in two children. One child had a Salter innominate osteotomy and the other Dega osteotomy respectively. A

Table 1: Patient demographics that underwent revision surgery with intra-operative findings.

NO	AGE (MONTHS)			G	PI	SI	REVISION FINDINGS			SIDE
	PS	DIS	RS				LT	PSOAS	TAL	
1	24	4	30	B	OR	OR+V	A	P	P	L
2	9	NR	24	G	OR	OR+V	A	A	P	L
3	18	3	22	G	OR	OR+V	A	A	A	R
4	18	NR	28	G	OR+V	OR+V+S	P	P	P	R
5	18	SPICA	26	G	OR+V+D	OR+V	A	A	A	R
6	22	SPICA	32	B	OR+V	OR+V	A	A	A	R
7	16	4	22	G	OR	OR	P	A	A	L
8	24	5	36	G	OR	OR+V	A	A	A	L
9	22	SPICA	30	G	OR	OR+V	P	A	A	R
10	18	4	48	G	OR	OR+V+D	A	P	P	R
11	20	4	36	B	OR	OR+S	A	P	P	L
12	18	NR	24	G	OR	OR+S	A	P	P	L
13	22	SPICA	30	G	OR+S	OR+V	A	P	A	R
14	18	6	24	B	OR	OR+V	A	A	A	L
15	22	4	30	B	OR+S	OR+V	A	A	A	L
16	20	3	28	G	OR	OR+S	A	A	A	L
17	24	5	48	B	OR	OR+V	A	A	A	R
18	24	3	36	G	OR+V	OR+V	A	A	A	BI

Table 2: Results of revision surgery in 18 cases

NO	FA	TT	AVN	Radiological	LLD	FU (MONTHS)
	Mod Ponseti		Kalamchi	Severin		
1	1	A	1	2	0	48
2	4	P	4	3	2	36
3	2	A	2	2	0	48
4	2	P	2	2	1	16
5	2	A	1	1	0	24
6	1	A	1	2	0	26
7	1	A	1	2	0	30
8	2	P	2	2	1	36
9	4	P	3	3	2	34
10	3	P	2	2	1	22
11	1	A	1	1	0	26
12	1	A	1	2	0	24
13	3	P	2	2	0	27
14	2	A	1	1	1	18
15	4	P	2	3	1	24
16	2	A	1	1	1	22
17	3	P	1	2	1	20
18	4	P	4	3	1	34

trans-articular wire was used in all cases and an interval spica change was performed under anesthesia at 4 – 5 weeks with removal of the wire.

Results

The mean age at first surgery was 19 months (range: 9 to 24 months) and for revision surgery was 30 months (range 22 to 48 months) respectively. In fourteen cases, the primary surgery was performed at an outside center including the two children (3 hips) who had undergone one previous revision (one unilateral and one bilateral case). Four primary surgeries were performed at our institute. Nine and eight dislocations involved the left and right hips respectively and one child had bilateral dislocation.

The mean follow-up period was 28 months (range 16 months to 48 months).

We have modified the Ponseti8 score to include "squatting and sitting cross legged" as this is a common expectation in the Indian subcontinent. Five children with Ponseti score grade 1 had full range of hip motion and were able to completely squat and walk without a limp. Four children (5 hips) had a poor score with limp and gross restriction of motion with difficulty in sitting cross legged. The Trendelenburg test was positive in nine children. 16 children had limb length discrepancy less than 2 cm and in two children the inequality was more than 2 cm. They are under review for the possibility of contra-lateral epiphysiodesis.

Radiological assessment at last follow-up revealed four hips in Severin grade 1, and ten hips in Severin grade 2.15 Only two children had pre-operative CT scans before revision surgery. The avascular necrosis (AVN) was recorded at the final follow-up radiograph using the Kalamachi classification [16]. Two hips had severe AVN (Grade 4). Nine had mild changes but this did not impact the clinical outcome.

The child with bilateral hip dislocation had re-dislocated both hips at follow up. On examination there was no anti-gravity power in the hip abductors despite normal neurology. We elected not to perform any further interventions for this child.

Discussion

Failure of primary DDH surgery can be a setback to the treating surgeon and calamitous for the child and caregivers. Failures can be classified as immediate, delayed or late depending on the duration after the initial surgery [17]. Surgical expertise and technical factors such as inadequate capsular release, poor capsulorrhaphy, and simultaneous VDO and Salter's osteotomy can pre-dispose to early failure [2, 3, 7, 8]. In our study, the surgical approach was sub-optimal in four cases. This resulted in inadequate exposure of the hip joint and poor initial reduction

Table 3: Functional and Radiological assessment of the revision cases with modified Ponseti Score

	N = NUMBER	%
MOD.PONSETI SCORE	N =18	
1	5	27.7
2	6	33.3
3	3	16.6
4	4	22.2
SEVERIN SCORE	N = 19	
1	4	22.2
2	10	55.5
3	3	16.6
4	2 (B)	11
KALAMACHI	N =19	
1	9	50
2	6	33.3
3	2	5
4	2	11

[6, 11, 18]. Poor hip spica cast application can also cause failure. This delayed failure occurs after hip spica removal in hips that the surgeon felt had been located and were stable intra-operatively. Four cases in this study dislocated after spica removal. One was due to excessive femoral anteversion. This child underwent an open reduction without VDO. One child had OR with concomitant VDO and Dega and 2 children had a Salter osteotomy combined with OR. In these cases, posterior uncovering of the head caused the re-dislocation. Thus, adequate stabilization and immobilization are key to preventing this type of delayed failure. Late failures occur due to poor acetabular and abnormal femoral remodeling after a stable reduction [17]. Avascular necrosis (AVN) of the hip can also contribute to this inadequate remodeling in the intervening period [8, 13, 19, 20]. Sankar et al analyzed the risk factors for re-dislocations in 25 cases [11]. The authors reported that inadequate hip abduction in spica cast, right sided and bilateral hips, an abnormal femoral anteversion and dysmorphic femoral head are more prone to failures. Bassam et al studied 52 children that underwent revision hip surgery [8]. They concluded that proclivity for failure increases with poor initial exposure, excessive derotation of the proximal femur and concomitant VDO and Salter's procedure. Kershaw et al had stated that there is no role for closed reduction or only bony surgery during revision surgery. Open reduction is mandated to clear the acetabulum of soft tissues. They emphasized that the prime reasons for failure are technical. Capsule repair is of utmost importance. Overtightening or capsular dehiscence can lead to posterior hip dislocation especially if a Salter procedure has been undertaken concurrently [3]. We encountered this problem in two cases where OR was combined with a Salter procedure and the hip redislocated posteriorly. We now avoid excessive tightening of the capsule and routinely use a trans-articular pin in all cases to supplement the capsule repair as reported by other authors [21].

The outcomes after revision DDH surgery are always suboptimal compared to primary surgery. Several authors have used the Ponseti score to rate outcomes after revision DDH surgery [2, 3, 8]. We have modified this score to include cross-leg sitting and squatting as this is a common posture adopted in our society. Bassam et al had 43 children (82.7%) with excellent outcome (Ponseti Score 1 & 2) and only nine children with a limp. In our study 11 children (61%) had an excellent outcome, three children (16%) had mild limp and incomplete squatting and 4 children (22%) had gross limp, inability to squat and LLD more than 2 cms. Trendelenburg test was positive in 9 children (50%) but this did not impact the functional assessment according to the modified Ponseti score. A common complication is AVN after any repeat surgery for DDH. Kershaw et al reported an AVN rate of more than 50% cases (19 hips) in their series of 33 hips, five of which caused severe distortion of the femoral head. The extensive soft tissue dissection and prolonged immobilization required for healing can compromise the blood supply [3]. We had 3 (16%) cases of severe AVN, of which one child had undergone previous hip surgery. Six (33.3%) had lateral physeal arrest and are being monitored for coxa valga. The remaining nine had minor changes. The sphericity of the head and femoral head-neck geometry also undergoes changes after repeat surgery.

The time frame of dislocation was a cause for concern in the study. Early or immediate failure was seen in four children (22.3%) due to lack of adequate initial reduction. Delayed dislocation or failure from time to spica removal and within 6 months occurred in the remaining 14 (77.7%) children. Thus, failure to identify the true acetabulum due to inappropriate approach, poor intra-operative stabilization and inadequate spica application are the main factors responsible for failure. No late dislocations were seen in this study.

The limitations of a retrospective assessment are inherent in the study. To cite a few lacunae; in some children the follow up was irregular; spica changes were often undertaken by a different surgeon if the patient could not travel; a complete set of radiographs and periodic charts were not available in all cases.

Conclusion

In conclusion, immediate and delayed failure are preventable causes for failure following open reduction in DDH. Primary DDH surgery should be undertaken by an experienced surgeon to minimize technical errors and preferably at centers where the consistency of follow up can be maintained. Revision surgery is associated with less satisfactory outcomes compared to primary open reduction.

References

1. Chmielewski J, Albiñana J. Failures of open reduction in developmental dislocation of the hip. J Pediatr Orthop. 2002;11:284–9.

2. McCluskey WP, Bassett GS, Mora-Garcia G, MacEwen GD. Treatment of failed open reduction for congenital dislocation of the hip. J Pediatr Orthop. 1989;9:633.

3. Kershaw CJ, Ware HE, Pattinson R, Fixsen JA. Revision of failed open reduction of congenital dislocation of the hip. J Bone Joint Surg Br. 1993;75:744–9.

4. Tonnis D. Berlin, Heidelberg: Springer-Verlag; 1987. Congenital Dysplasia and Dislocation of Hip in Children and Adults.

5. Ponseti IV Causes of failure in the treatment of congenital dislocation of the hip. J Bone Joint Surg 1944; 26:775–792.

6. Wedge JH, Kelley SP. Strategies to improve outcomes from operative childhood management of DDH. Orthop Clin North Am. 2012;43:291–9.

7. Bos CF, Slooff TJ. Treatment of failed open reduction for congenital

dislocation of the hip. A 10-year followup of 14 patients. Acta Orthop Scand. 1984;55:531–5.

8. Abouelnas BA, Zaghloul K, Saied AM. Revision Surgery for developmental dysplasia of the hip (DDH). Egyptian Orth Jour. 2018-53:45-50.

9. 2. Hung, N.N. Revision of Outcomes and Complications Following Open Reduction, and Zigzag Osteotomy Combined with Fibular Allograft for Developmental Dysplasia of the Hip in Children. Open Journal of Orthopedics 2016:6, 184-200.

10. Chidambaram S, Abd Halim AR, Yeap JK, Ibrahim S. Revision surgery for the developmental dysplasia of the hip. Med J Malaysia 2005;60(C):91-98.

11. Sankar WN, Young CR, Lin AG, Crow SA, Baldwin KD, Moseley CF. Risk factors for failure after open reduction for DDH: A matched cohort analysis. J Pediatr Orthop. 2011;31:232–9.

12. Kamath SU, Bennet GC. Re-dislocation following open reduction for developmental dysplasia of the hip. Int Orthop 2005;29(3):191-194.

13. Brougham DI, Broughton NS, Cole WG, Menelaus MB. Avascular necrosis following closed reduction of congenital dislocation of the hip. Review of influencing factors and long term followup. J Bone Joint Surg Br. 1990;72:557–62.

14. Wenger DR, Congenital hip dislocation: Techniques for primary open reduction including femoral shortening. Instructional course lecture.1984;38:343-54.

15. Severin E. Contribution to knowledge of congenital dislocation of hip joint. Late results of closed reduction and arthrographic studies of recent cases. Acta Chir Scand. 1941;84(Suppl 63):1–142.

16. Kalamchi A, MacEwen GD. Avascular necrosis following treatment of the hip. J Bone Joint Surg Am 1980; 62:876–888.

17. Johari AN, Wadia FD. Revision Surgery for Developmental Dysplasia of the Hip. Indian J Orthop.2003;37:233-6.

18. Bhaskar A, Desai H, Jain G.Risk factors for early redislocation after primary treatment of developmental dysplasia of the hip: Is there a protective influence of the ossific nucleus? Indian J Orthop. 2016 Sep; 50(5): 479–485.

19. Harris NH. Acetabular growth potential in congenital dislocation of the hip and some factors upon which it may depend. Clin Orthop Relat Res. 1976;119:99–106.

20. Clarke NM, Jowett AJ, Parker L. The surgical treatment of established CDH: Result of surgery after planned delayed intervention following the appearance of capital femoral ossific nucleus. J Pediatr Orthop. 2005;25:434039.

21. Castañeda P, Tejerina P, Nualart L, Cassis N. The safety and efficacy of a transarticular pin for maintaining reduction in patients with developmental dislocation of the hip undergoing an open reduction. J Pediatr Orthop. 2015 Jun;35(4):358-62. doi: 10.1097/BPO.0000000000000284. PMID: 25075885.

22. Castañeda P, Masrouha KZ, Ruiz CV, Moscona-Mishy L. Outcomes following open reduction for late-presenting developmental dysplasia of the hip. Journal of Children's Orthopaedics. 2018;12(4):323-330. doi:10.1302/1863-2548.12.180078

Declaration of patient consent : The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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