Short Term Results of Developmental Dysplasia of Hip (DDH) Operated through Modified Medial Approach using two Intervals.

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ABSTRACT

Objective: To determine the short-term functional and radiological results in patients with Developmental Dysplasia of Hip (DDH) operated through a modified medial approach using two intervals.

Methods: This descriptive study was conducted in Paediatric Orthopedic Unit Children's Hospital and Institute of Child Health Lahore from 10th August 2019 to 10th August 2021.All children of DDH with age 18 months or less fulfilling the inclusion criteria were operated through modified medial approach using two intervals. Post operative functional results were assessed with McKay criteria and graded as excellent, good,fair and poor. Radiographic evaluation was done with Severin's classification. Avascular necrosis(AVN) was classified using Kalamchi and MacEwen classification.

Results: In this study 21 patients were included. The Mean age at the time of primary surgery was 12.5 ± 2.9 months, Females were 14 (66.66%) and males were 7(33.33%). Mean Post operative follow-up period was 16.7 ± 3.3 months. Excellent functional outcome was noted in 17(80.95%) and good in 4(19.04%) as per McKay's criteria. Radiographically 17(80.95%) patients had Severin's Class I, 3(14.28%) had Class II and 1(4.76%) patient had Severin's Class III outcome. We noted that 1(4.76%) patient developed AVN(Kalamchi and MacEwen group II)

Conclusion: Excellent and good short term functional and radiological results were achieved in DDH patients treated with modified medial approach using two intervals.

Keywords: Avascular Necrosis, Developmental Dysplasia of the Hip, Medial Approach**,** Open Reduction.

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INTRODUCTION

Developmental Dysplasia of Hip (DDH) is a wide spectrum of abnormal hip development ranging from mild acetabular dysplasia without hip dislocation to frank hip dislocation.[1] Normal hip joint development requires congruent hip reduction which can be achieved in DDH through closed reduction (CR) or open reduction (OR) within the first two years of age.[2,3] Controversy exists in the literature regarding the timing and type of surgical approach for DDH surgery. [2] DDH in the early stage can be operated through two standard approaches; the anterior and the medial approach.[4,5] The anterior approach gives good exposure of the extra and intra-articular obstacles but the scar is cosmetically unappealing and there is an increased risk of lateral femoral cutaneous nerve injury.[6] The medial approach is cosmetically acceptable and gives direct access to intra-articular interpositions but at the cost of increased risk of AVN and limited exposure for capsulorraphy.[7,8] The medial approach was first described by Ludloff in 1908, later modified by Ferguson, Weinstein, and Ponseti.[9] The major concern with the medial approach is AVN of the femoral head due to an iatrogenic injury to the medial circumflex femoral artery.[10,11] There has been a continuous debate among the authors as to how to reduce the risk of osteonecrosis in the medial

approach for DDH surgery.[12,13] One valid hypothesis mentioned in the literature is that using two separate intervals for iliopsoas tenotomy and capsulotomy reduces the risk of ANN as this approach avoids medial circumflex artery in the surgical field. Furthermore, the pectineus fascia shields the femoral nerve and vessels as the capsulotomy is done in front of the pectineus muscles.[14,15]

We conducted this study to evaluate the functional and radiological outcomes in patients up to 18 months of age who underwent open reduction for DDH through a medial approach using two separate intervals.

METHODS

We conducted this descriptive study in Paediatric Orthopedic Unit Children's Hospital and Institute of Child Health Lahore from 10th August 2019 to 10th August 2021.All children of DDH with age 18 months or less who were operated through modified medial approach using two intervals were included in this study. Exclusion criteria were patients in whom hip dislocation was infective,post-traumatic, teratogenic, or associated with other musculoskeletal problems.

The study was approved by the Ethical Committee of our hospital. Informed written consent was obtained from parents of all participants. All the children were thoroughly examined and radiographs were obtained for pre operative planning.

Surgical Technique

All the surgeries were performed by the same surgical team. Closed reduction under anesthesia was first tried and adductor tenotomy with a stab incision was added if the closed reduction was not possible. The modified medial approach that we used involved a 3 cm transverse incision centered over the adductor longus at its proximal attachment. After subcutaneous dissection Adductor Longus tenotomy was carried out with electrocautery at its proximal attachment. We used two different intervals for iliopsoas and "T" shaped capsulotomy. For iliopsoas tenotomy, in type II and III dislocations, the Adductor Longus-Pectineus interval anterior to Adductor Longus was used while in type IV dislocation the Adductor Longus-Brevis interval posterior to Adductor Longus was applied. Adductor Brevis is retracted medially while Pectineus was retracted laterally along with the femoral nerve and vessels. Iliopsoas tenotomy was carried out at the level of the minor trochanter because at this place the medial circumflex artery is not confronted directly in the surgical field. The capsulotomy was done using the Pectineus and Iliopsoas interval. The fascia containing femoral vessels which lies anterolateral to the Pectineus was lifted anterolateral with a retractor over the capsule. Pectineus and Adductor Longus were retracted with a second retractor thus exposing the underlying capsule. A longitudinal capsulotomy along the femoral neck was performed and intra-articular obstacles including thickened ligamentum teres and pulvinar were removed. Following this step femoral head was easily reduced in the acetabulum and capsuloraphy was performed.

Postoperatively spica cast was applied in human position for 3 months. The abduction brace was applied for another 3 to 6 months depending upon the age of the patient. Postoperative follow-up protocol followed in our department was 3 weekly for the first 3 months followed by every three months for 1 year. For the initial three months of spica cast patient hygiene and follow-up radiographs for hip reduction were noted. After removal of the cast at each follow-up clinical examination and radiographs were taken to make relevant measurements. AP and frog-leg lateral radiographs were taken on the last follow-up at 1 year to see the signs of AVN of femoral head, degenerative arthritis and central-edge (CE) of Wiberg, acetabular index. Patient radiographic findings were graded according to Severin's classification.(table I).[16] AVN of femoral head was graded according to Kalamachi-MacEwen classification.(table II)[17] Functional outcome was evaluated using McKay criteria and graded as excellent, good, fair and poor. (table III)[16]

Table I: McKay's criteria for assessing post operative functional outcome.

McKay Grade	Rating	Description
Grade I	Excellent	The hip is painless, stable, no limping, full range of motion, negative Trendelenburg sign
Grade II	Good	The hip is painless, stable, slight limping, range of motion is slightly decreased, negative Trendelenburg sign
Grade III	Fair	The hip is painless, stable ,limping, range of motion is limited, positive Trendelenburg sign or combination of these
Grade IV	Poor	Unstable hip,painful hip or both, positive Trendelenburg sign

Table II: Kalamchi and MacEwen classification of avascular necrosis of the head of femur.

Kalamchi and MacEwen groups	Description
Kalamchi and MacEwen group I	Temporary changes in Ossific Nucleus due to partial vascular insult. Complete resolution in long term
Kalamchi and MacEwen group II	Physeal damage laterally resulting in coxa valga, minimum leg length discrepancy, early degenerative osteoarthritis of the hip joint
Kalamchi and MacEwen group III	Physeal damage at the center of head of femur resulting in coxa vara,limping and osteoarthritis
Kalamchi and MacEwen group IV	Deformity of the head and neck of femur due to Physeal and head damage,leg length discrepancy,osteoarthritis, limited range of hip motion.

Table III: Severin's classification for assessing post operative radiographic outcome.

Severin's Class	Description	Centre-Edge angle(degrees)
I	Normal	≥15 degrees(5 to 13 years) ≥20 degrees(>14 years)
II	Head of femur, neck of femur or acetabulum is mildly deformed	≥15 degrees(5 to 13 years) ≥20 degrees(>14 years)
III	Head of femur, neck of femur or acetabulum is moderately deformed or both	<15 degrees(5 to 13 years) <20 degrees(>14 years)
IV	Head of femur is subluxad	--
V	Head of femur articulated with false acetabulum	--
VI	Redislocation	--

The data was analyzed with SPSS version 23.Quantative variables were represented as mean and standard deviation. Qualitative variables were represented as frequency and percentages. Comparison of important variables were done and P value was calculate with the help of Chi-square test and paired sample-t test. P value <0.05 was considered significant.

RESULTS

We operated 21 children of DDH via medial approach. The mean age at the time of primary surgery was 12.5 ± 2.9 months(range 7 to 18 months). Females were 14(66.66%) and males were 7(33.33%). Mean Post operative follow-up period was 16.7 ± 3.3 months(range 13 to 19 months). Based on pre operative Tonnis grading 2(9.52%) hips were type II, 9(42.85%) hips were type III, and 10(47.61%) hips were type IV. The mean preoperative acetabular index (AI 1) was 38.7° (range 32 to 50°) while the mean postoperative acetabular index (AI 2) was 30.2° (range 22 to46°). There was a statistically significant difference (p<.01) between the means of preoperative and postoperative acetabular indices(p=0.01)At one year follow up excellent functional outcome was noted in 17(80.95%) and good in 4(19.04%) as per McKay's criteria. Radiographically 17(80.95%) patients had Severin's Class I, 3(14.28%) had Class II and 1(4.76%) patient had Severin's Class III outcome. We noted that 1(4.76%) patient developed AVN(Kalamchi and MacEwen group II)

DISCUSSION

Hip containment surgery for DDH is aimed to achieving stable and concentric hip reduction which is necessary for normal hip development in early childhood.[5] There is a strong evidence from literature that earlier the treatment is started for DDH the better are the success rate and the more remodeling potential of the hip joint with lower complication rates.[18] Medial approach with Ludloff's method for DDH surgery is preferred because of the smaller incision, direct approach to the offending structures, relatively less dissection and lower blood loss. Through the same incision the Adductor Longus is released, the antero inferior tight structures including iliopsoas, capsule, and transverse acetabular ligament are directly addressed and released. The residual scar is small and cosmetically acceptable.[19-21] The medial circumflex femoral artery however is encountered directly into the surgical field and during dissection direct injury or traction injury to these vessels may lead to the increased percentage of osteonecrosis of the femoral head.[22] Another drawback limiting the use of this approach is that the

exposure is limited and extra-articular obstacles including the posterior aspect of the capsule, shortened external rotators, capsular constrictions, and torsion cannot be approached adequately thus increasing the chances of residual subluxation or dislocation postoperatively.[23,24] The success rate of medial approach is high for infants operated up to 12 months compared to patients whose age at surgery was 13-18 months.[25,26]

For infants with early hip containment, surgical procedure is favorable as abnormal structures in and around the deformed hip are less stiff not only reducing the chances of residual subluxation and dislocation but also a high remodeling potential of developing acetabulum for early concentrically reduced hip.[27,28]

Contrary to the famous belief by Salter18 that there is no osseous development of acetabulum after 18 months' age, recent literature has shown that development of femoral head or acetabulum continues till 8 to 10 years of age provided that the hip joint is concentrically reduced.[29,30] This finding advocates long-term follow-up of operated cases till skeletal maturity.

AVN of the femoral head is one of the most serious complications of medial approach secondary to medial circumflex artery injury.[10] The incidence of AVN varies from 0 to 67% in different studies.[31-35] In our study we reported an incidence of AVN was 4.7% (1/21 hips).The patient of AVN was Tonus type IV, and closed reduction was tried before OR. The low rate of AVN in our study is best explained by the modified medial approach where two separate intervals were used for IP release and capsuloraphy favoring less dissection and avoids medial circumflex artery at the surgical field.

Using Severin's radiological assessment, Castillo and Sherman[34] in their series observed excellent and good results in 73% cases while Sener[33] and Danielson[35] reported excellent and good results in 50% and 99% respectively. In our study 17(80.95%) patients had Severin's Class I, 3(14.28%) had Class II and 1(4.76%) patient had Severin's Class III outcome.

Our study had few limitations. Our sample size was small and with short follow up period. Further studies are required to confirm the usefulness of medial approach for treating DDH.

CONCLUSION

Excellent and good short term functional and radiological outcome was achieved in DDH patients treated with modified medial approach using two intervals.

Conflict of Interest: None

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REFERENCES

1. Akilapa O. The medial approach open reduction for developmental dysplasia of the hip: do the long-term outcomes validate this approach? A systematic review of the literature. J Child Orthop. 2014;8(5):387-397.
2. Ozkut AT, Iyetin Y, Unal OK, Soylemez MS, Uygur E, Esenkaya I. Radiological and clinical outcomes of medial approach open reduction by using two intervals in developmental dysplasia of the hip. Acta Orthop Traumatol Turc. 2018;52(2):81-86.
3. 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(3):406-13.
4. Jia G, Wang E, Lian P, Liu T, Zhao S, Zhao Q. Anterior approach with mini-bikini incision in open reduction in infants with developmental dysplasia of the hip. J Orthop Surg Res. 2020 ;15(1):180.
5. Turkozu T, Gune Sr, Ceylan MF, Guven N. The outcomes of open reduction by the medial approach for developmental dysplasia of the hip in the 3-18 months old patients. East J Med Volume.2017;22(2):212-219.
6. Sankar WN, Gornitzky AL, Clarke NMP, Herrera-Soto JA, Kelley SP, Matheney T, *et al.* Closed Reduction for Developmental Dysplasia of the Hip: Early-term Results From a Prospective, Multicenter Cohort. J Pediatr Orthop. 2019;39(3):111-118.
7. Bulut M, Gurger M, Belhan O, Batur OC, Celik S, Karakurt L. Management of developmental dysplasia of the hip in less than 24 months old children. Indian J Orthop. 2013 ;47(6):578-584.
8. Morcuende JA, Meyer MD, Dolan LA, Weinstein SL. Long-term outcome after open reduction through an anteromedial approach for congenital dislocation of the hip. J Bone Joint Surg Am. 1997;79(6):810-817.
9. Presch C, Eberhardt O, Wirth T, Fernandez FF. Comparison of arthroscopic and open reduction of conservatively irreducible dislocated hips of children. J Child Orthop. 2019;13(4):377–384.
10. Kalamchi A, Schmidt TL, MacEwen GD. Congenital dislocation of the hip: open reduction by the medial approach. Clin Orthop Relat Res. 1982;169:127–132.
11. Hines AC, Neal DC, Beckwith T, Jo C, Kim H. A comparison of Pavlik harness treatment regimens for dislocated but reducible (Ortolani+) hips in infantile developmental dysplasia of the hip. J Pediatr Orthop. 2019;39(10):505–509.
12. Tumer Y, Bicimoglu A, Agus H. Surgical treatment of hip dysplasia through the medial approach. Acta Orthop Traumatol Turc. 2007;41(1):31-36.
13. Mankey MG, Arntz GT, Staheli LT. Open reduction through a medial approach for congenital dislocation of the hip. A critical review of the Ludloff approach in sixty-six hips. J Bone Joint Surg Am. 1993;75(9):1334-1345
14. Baki C, Sener M, Aydin H, Yildiz M, Saruhan S. Single-stage open reduction through a medial approach and innominate osteotomy in developmental dysplasia of the hip. J Bone Joint Surg Br. 2005;87-B:380–383.

15. Iyetin Y, Turkmen I, Saglam Y, Akcal MA, Unay K, Unsac B. A modified surgical approach of the hip in children: is it safe and reliable in patients with developmental hip dysplasia? J Child Orthop. 2015;9(3):199-207.
16. Bhuyan BK. Outcome of one-stage treatment of developmental dysplasia of hip in older children. Indian J Orthop 2012;46:548-555.
17. Kalamchi A, MacEwen GD. Avascular necrosis following treatment of congenital dislocation of the hip. J Bone Joint Surg Am. 1980;62:876–888.
18. Salter RB. Innominate osteotomy in the treatment of congenital dislocation and subluxation of the hip. J Bone Joint Surg Br. Aug.1961;43:518-539
19. Ludloff K. The open reduction of the congenital hip dislocation by an anterior incision. Am J Orthop Surg. 1913;210(3):438-454.
20. Ferguson Jr AB. Primary open reduction of congenital dislocation of the hip using a medial adductor approach. J Bone Joint Surg Am. 1973;55: 67l-689.
21. Staheli LT. Medial approach open reduction for congenitally dislocated hips: a critical review of forty cases. In: Tachdjian MO, ed. Congenital Dislocation of the Hip. New York: Churchill Livingstone; 1982:295-303.
22. Chiari K. Die operative Behandlung am Huftgelenk bie der angeborenen Huftgelenksverrenkung. Wiener Itied Wochenschr.1957;107: 1020-1023.
23. Weinstein SL, Ponseti IV. Congenital dislocation of the hip. Open reduction through a medial approach. J Bone Joint Am. 1979 ;61(1):119-124.
24. Mau H, Deorr WM, Henkel L. Open reduction of congenital dislocation of the hip by Ludloff's method. J Bone Joint Surg Am. 1971;53(7):1281-1288
25. Konigsberg DE, Karol LA, Colby S, O'Brien S. Results of medial open reduction of the hip in infants with developmental dislocation of the hip. J Pediatr Orthop. 2003;23(1):1-9.
26. Koizumi W, Moriya H, Tsuchiya K, Takeuchi T, Kamegaya M, Akita T. 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(6):924-929.
27. Mergen E, Adyaman S, Omeroglu H, Erdemli B, Isiklar U. Medial approach open reduction for congenital dislocation of the hip using the Ferguson procedure. A review of 31 hips. Arch Orthop Trauma Surg 1991;110: 169-172.
28. Di Mascio L, Carey-Smıth R, Tucker K. Open reduction of developmental hip dysplasia using a medial approach: A review of 24 hips. Acta Orthop Belg 2008; 74,3: 343-348.
29. Tasnavites A, Murray D, Benson M. Improvement in the acetabular index after reduction of hips with developmental dysplasia. J Bone Joint Surg Br.1993;75-B:755–759.
30. Cherney DL, Westin G. Acetabular development in the infant's dislocated hips. Clin Orthop Relat Res.1989; 242:98–103.
31. Lalonde FD, Frick SL, Wenger DR. Surgical correction of residual hip dysplasia in two pediatric age-groups. J Bone Joint Surg Am. 2002;84(7):1148-1156.
32. Lempicki A, Wierusz-Kozlowska M, Kruczynski J. Abduction treatment in late diagnosed congenital dislocation of the hip. Follow-up of 1,010 hips treated with the Frejka pillow 1967e76. Acta Orthop Scand Suppl. 1990; 236:1-30.
33. Sener M, Baki C, Aydin H, Yildiz M, Saruhan S. The results of open reduction through a medial approach for developmental dysplasia of the hip in children above 18 months of age. Acta Orthop Traumatol Turc 2004; 38: 247-251.
34. Castillo R, Sherman FC. Medial adductor open reduction for congenital dislocation of the hip. J Pediatr Orthop 1990; 10: 335-340.
35. Danielsson L. Late-diagnosed DDH: a prospective 11-year follow-up of 71 consecutive patients (75 hips). Acta Orthop. Scand 2000; 71: 232-324