 Acta Chir Orthop Traumatol Cech. 90, 2023, No. 1
p. 17–21

ORIGINAL PAPER
PŮVODNÍ PRÁCE

Functional and Radiologic Results of Posteromedial Limited Surgery in Developmental Dysplasia of the Hip

Funkční a radiologické výsledky posteromediální limitované chirurgické terapie u vývojové dysplazie kyčelních kloubů

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ABSTRACT

PURPOSE OF THE STUDY

In treatment algorithm of developmental dysplasia of the hip, posteromedial limited surgery is placed between closed reduction and medial open articular reduction. The aim of the present study was to assess the functional and radiologic results of this method.

MATERIAL AND METHODS

This retrospective study was performed in 37 Tönnis grade II and III dysplastic hips of 30 patients. The mean age of the patients at operation was 12.4 months. The mean follow-up time was 24.5 months. Posteromedial limited surgery was applied when sufficient stable concentric reduction was not achieved by closed technique. No pre-operative traction was applied. Postoperatively, human position hip spica cast was applied for 3 months. Outcomes were evaluated regarding modified McKay functional results, acetabular index and presences of residual acetabular dysplasia or avascular necrosis.

RESULTS

Thirty-six hips had satisfactory and one hip had poor functional result. The mean pre-operative acetabular index was 34.5 degrees. It improved to 27.7 and 23.1 degrees at the postoperative 6th month and the last control X-Rays. The change in acetabular index was statistically significant ($p<0.05$). At the last control, 3 hips had findings of residual acetabular dysplasia and 2 hips had avascular necrosis.

CONCLUSIONS

Posteromedial limited surgery for developmental dysplasia of the hip is indicated when closed reduction remains insufficient and medial open articular reduction remains unnecessarily invasive. This study, in line with the literature, provides evidences that this method might decrease the incidences of residual acetabular dysplasia and avascular necrosis of the femoral head.

Key words: developmental dysplasia of the hip, posteromedial limited surgery, closed reduction, medial open reduction.

INTRODUCTION

In treatment algorithm of developmental dysplasia of the hip (DDH), posteromedial limited surgery (PMLS) is placed between the closed and the open articular reduction through medial approach (3, 6, 7). The aim of this operative technique is to discard the reduction-inhibiting effects of the stretched tendons of the iliopsoas and the adductor longus muscles. It has been described in treatment of Tönnis grade II and above dysplastic hips of patients between the ages of 3 to 18 months. In these patients, PMLS provides better concentric reduction where closed reduction techniques (CRT) remain insufficient verified by intra-operative arthrography (6, 7, 8, 23). On the other hand, as PMLS involves no arthrotomy component, the risk of avascular necrosis development is less than medial open reduction (MOR) surgery (3, 6, 16). In this study we aimed to assess postoperative functional and radiologic results in DDH patients who underwent PMLS.

PATIENTS AND METHODS

Study group

This study was done in University of Dicle, School of Medicine, Department of Orthopaedics and Traumatology, Diyarbakir, Turkey. After the approval of the institutional ethical committee for clinical research ethics committee of the university, hospital records of DDH patients who were operated using PMLS technique were

compiled retrospectively. Parents of the patients were informed of the aim of the study according to the principles of the Declaration of Helsinki. They were informed that study data would be submitted for publication and their consent was obtained. Patients who had less than 18 months of postoperative follow-up or technically insufficient X-rays were excluded. Thirty patients (27 girls and 3 boys) were found eligible to be included into the study. The mean age of these patients at the time of surgery was 12.4 (5–23) months. Nineteen patients had bilateral DDHs and 4 had a history of Pavlik harness application. Bilateral PMLS was performed in 7 patients. In 6 patients, concentric closed reduction was found sufficient by arthrography in the contralateral hip and PMLS was done to the present one. In the remaining 6 patients with bilateral DDH, arthrographic concentric reduction could not be achieved by PMLS in one hip and MOR was performed. Thus, parameters of the study were assessed in 37 hips of these 30 patients. The last controls of the patients were done after an average of 24.5 (18–43) months after the operation.

Treatment procedure

Prior to the surgery, parents of the patients were informed about the arthrography and the treatment options including CRT, PMLS and MOR. A written consent was obtained. From total 37 hips, 30 were evaluated as Tönnis grade II and 7 as grade III. The indications for this treatment were made according to the algorithm described by Bicimoglu et al. (6, 7). In brief, PMLS was applied to the hips with unsuccessful concentric closed reduction verified by arthrography. In patients over the age of 18 months, presence of Tönnis grade II hip, positive Ortolani test under anesthesia and stable concentric reduction after PMLS were accepted as optimal outcome of the procedure.

Prior to the surgery, no traction was applied. In the first step, closed reduction and arthrography of the hip was done under general anesthesia. Standard anteroposterior and frog-leg position X-rays were obtained. The adequacy and stability of the closed reduction was determined according to the measures suggested previously in the literature (13, 29, 30). Similar to the study pub-

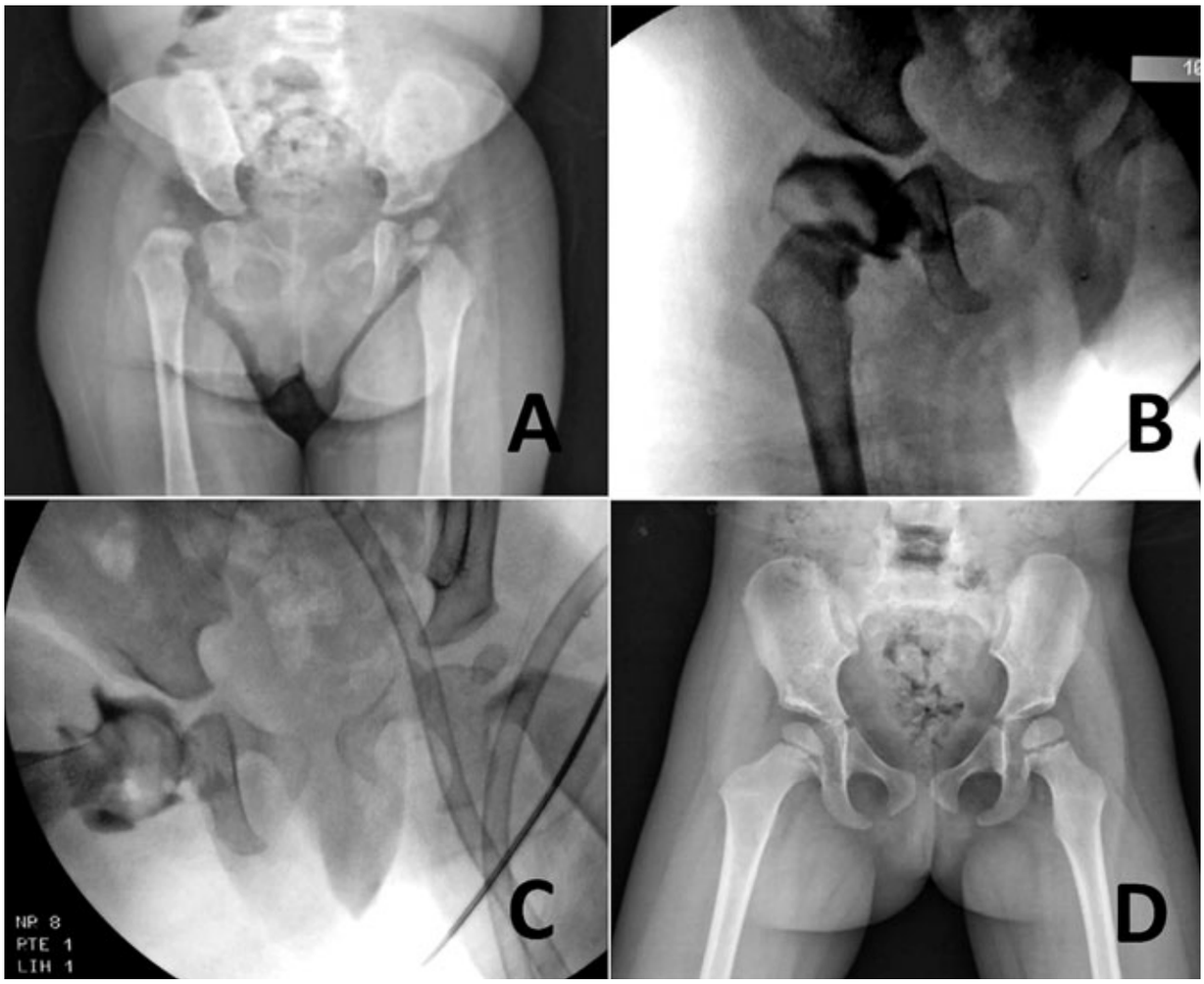

Fig. 1. 15-month-old patient's (A) pre-operetive X-ray, (B) intra-operatif arthrography, (C) arthrography after adductor longus and iliopsoas tenotomies and (D) postoperative 21st month X-ray.

lished by Drummond et al. (13) we accepted the width of the medial ponding less than 2 mm as prime criterion of stable concentric reduction (Fig. 1).

The procedure of PMLS and postoperative follow-up was performed as described previously (6, 7). In brief, adductor longus and iliopsoas tendons were sectioned through a Ferguson medial approach. Arthrography was repeated after unforced reduction of the hip by positioning extremity in flexion and abduction. If stable concentric reduction was obtained, a hip spica cast in human position was applied. In the case of an unsatisfactory result, the procedure was advanced to MOR. After 3 months the cast was removed. A full-time abduction brace was applied for 3 months followed by another 3 months of night-time use only.

Evaluated parameters

The functional outcomes of the patients were evaluated at the last control using modified McKay clinical evaluation system (5). In this system, pain, stability, limping, range of motion and Trendelenburg sign are assessed. Based on these criteria the outcomes were categorized to four grades ranging from excellent to poor. Excellent outcomes defined as painless, stable hip; no limp; more than 15 of internal rotation, good outcomes defined as painless, stable hip; slight limp or decreased motion; negative Trendelenburg's sign, fair outcomes defined as minimum pain; moderate stiffness; positive Trendelenburg's sign and poor outcomes defined as significant pain. We considered good and excellent results as satisfactory.

Radiological assessments were done by 4 observers. Acetabular index was measured on pre-operative, postoperative sixth month and the last control anteroposterior pelvic X-rays. The averages of observers' measurements were used in statistical analysis. Presence of broken Shenton-Menard line and upward slope of the sourcil were evaluated on the last control X-rays. The development of avascular necrosis was evaluated according to Kalamchi-MacEwen evaluation system (16, 17). In this system, grade-1 reflects changes that are confined to the ossific nucleus. In grade-2, lateral half of the growth plate and in grade-3 central physis are involved. Grade-4 indicates total physeal and head involvement. In radiologic parameters of Shenton-Menard line, slope of sourcil and avascular necrosis, agreement of at least 3 of observers was accepted as final decision. For cases with conflict among observers, a consensus meeting was held with the participation of all.

Presence of one of the criteria of broken Shenton-Menard line, upward slope of the sourcil or acetabular index over 35 degrees on the last X-ray was accepted as residual acetabular dysplasia (2, 16, 18).

Statistical analysis

SPSS for Windows version 15.0 software program (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Kolmogorov-Smirnov test was used to analyze whether continuous variables show normal distribution. The homogeneity of these variables was analyzed with the Levene test. Repeated Measures ANOVA was used for comparison of periodical angular measurements. Bonferroni tests were used for multiple comparisons. Confidence interval of 95% was applied in all tests and p values less than 0.05 were considered to be statistically significant.

RESULTS

Regarding the McKay clinical evaluation system, functional outcomes of 36 hips (97.3%) were satisfactory (36 hips were excellent) while poor in the other one (2.7%).

Acetabular indexes of the hips showed statistically significant ($p<0.05$) changes after PMLS. The mean of acetabular indexes was 34.5 (SD 4.6) on the pre-operative, 27.7 (SD 4.4) on the postoperative 6th month and 23.1 (SD 5.3) degrees on the last control X-rays.

Regarding radiological assessments, in 3 hips (8.1%) there was at least one of the criteria of development of residual acetabular dysplasia. The Shenton-Menard line was broken in all of these three patients. In one of these patients, the final control acetabular index angle was 44 degrees. These 3 hips required a consecutive osseous acetabular operation.

Regarding Kalamchi-MacEwen evaluation system, in two hips (5.4%) a grade I avascular necrosis developed. One of these two patients was the one with poor functional outcome.

Other than the 3 hips with residual acetabular dysplasia and two hips with avascular necrosis, no other early or late surgical complications were encountered. None of the patients required intra or postoperative blood transfusion.

DISCUSSION

In management algorithm of DDH, the main purpose is to achieve a stable concentric reduction as early as possible with treatment methods as less invasive as possible. Posteromedial limited surgery technique has been defined in accordance with this main purpose and is positioned between closed reduction and open articular reduction through medial approach (3, 6, 7, 16). We aimed to report our functional and radiologic outcomes after PMLS and compare them with previously published outcomes.

Regarding parameters contained by modified McKay clinical evaluation system, it seems that the functional results of CRT, PMLS and MOR are comparable. The rate of satisfactory results is reported to change between 80 to 100% for CRT, (1, 10, 11) 91 to 100% for PMLS, (3, 6, 8) and 93 to 100% for MOR (12, 14, 24). Our functional results (97.3% satisfactory) were correlated with the literature.

Post-reduction acetabular development is monitored by measuring acetabular index. Decrease of acetabular index below 24° suggests satisfactory acetabular development (33). The fastest progression of acetabular development occurs in the first 6 months period after suc-

cessful reduction(4, 33). PMLS technique provides improvement in acetabular index as much as other methods. Biçimoğlu et al. reported in their study that the acetabular index angle decreased from 44.8^0 to 20.4^0 in patients who underwent PMLS±MOR technique (7). Similarly, Araç et al. reported that the preoperative acetabular index angle was 33^0 and the final control acetabular index angle was 24^0 in patients who underwent PMLS in their study (3). In accordance with the literature, we found the change of the acetabular indexes to be significant at the 6th postoperative month X-ray.

In DDH patients treated insufficiently, residual acetabular dysplasia leads to secondary osteoarthritis. For prevention, early stable concentric reduction is mandatory (2, 18). The rate of residual acetabular dysplasia is reported to change between 9.7 to 43.6% for CRT (10, 20, 28, 31), 10 to 11% for CRT±PMLS (26, 29), 6.5 to 11.2% for PMLS (3, 6, 8), and 15 to 70.6% for MOR (12, 14, 22, 25, 27). These results suggest that the rate of residual acetabular dysplasia is lower after treatment by PMLS than CRT and MOR. Although in a shorter follow-up period, our results regarding this parameter were also in correlation with other studies on PMLS (3, 6, 8).

Avascular necrosis is the main complication of treatment in DDH. Its development is closely related to surgical damage to blood supply of the femoral head, postoperative immobilization position, and the tightness of the hip after reduction (6, 8, 15, 16). The reported rate of development of avascular necrosis changes between 4 to 60% for CRT (1, 4, 9, 10, 19, 20, 21, 26), 0 to 19.5% for PMLS (3, 6, 8) and 0 to 66 % for MOR (8, 12, 14, 16, 22, 25, 32). These results suggest that the rate of avascular necrosis is lower after treatment by PMLS than CRT and MOR. The reason might be less joint stiffness than CRT achievable with PMLS due to adductor and iliopsoas tenotomies. Regarding MOR, the reason is less surgical damage to blood supply of the femoral head by avoiding capsulotomy in PMLS. Our results regarding this parameter were correlated with previous studies on PMLS (3, 6, 8). However, the relatively short follow-up time was the weak point of the present study in relation with avascular necrosis results.

CONCLUSIONS

Posteromedial limited surgery is a treatment option with satisfactory functional and radiographic results in DDH patients between the ages of 5 to 23 months. It is indicated in patients where closed reduction techniques remain insufficient and medial open articular reduction remains unnecessarily invasive. This approach might decrease the incidences of residual acetabular dysplasia and avascular necrosis of the femoral head.

References

1. Aksoy MC, Ozkoç G, Alanay A, Yazici M, Ozdemir N, Surat A. Treatment of developmental dysplasia of the hip before walking: results of closed reduction and immobilization in hip spica cast. Turk J Pediatr. 2002;44:122–127.
2. Albinana J, Dolan LA, Spratt KF, Morcuende J, Meyer MD, Weinstein SL. Acetabular dysplasia after treatment for developmental dysplasia of the hip. Implications for secondary procedures. J Bone Joint Surg Br. 2004;86:876–886.
3. Arac S, Bozkurt M, Kiter E, Gunal I. Medial approach without opening the joint capsule for developmental dislocation of the hip. J Orthop Sci. 2003;8:522–525.
4. Barakat AS, Zein AB, Arafa AS, Azab MA, Reda W, Hegazy MM, Al Barbary HM, Kaddah MA. Closed reduction with or without adductor tenotomy for developmental dysplasia of the hip presenting at walking age. Curr Orthop Pract. 2017;28:195–199.
5. Berkeley ME, Dickson JH, Cain TE, Donovan MM. Surgical therapy for congenital dislocation of the hip in patients who are twelve to thirty-six months old. J Bone Joint Surg Am. 1984;66:412–420.
6. Biçimoğlu A, Ağuş H, Omeroğlu H, Tümer Y. Posteromedial limited surgery in developmental dysplasia of the hip. Clin Orthop Relat Res. 2008;466:847–855.
7. Bicimoglu A, Agus H, Omeroglu H, Tumer Y. Six years of experience with a new surgical algorithm in developmental dysplasia of the hip in children under 18 months of age. J Pediatr Orthop. 2003;23:693–698.
8. Bicimoglu A, Caliskan E. The long-term outcomes of posteromedial limited surgery for developmental dysplasia of the hip: a mean 17.3-year follow-up. J Pediatr Orthop B. 2019;28:115–121.
9. Bradley CS, Perry DC, Wedge JH, Murnaghan ML, Kelley SP. Avascular necrosis following closed reduction for treatment of developmental dysplasia of the hip: a systematic review. J Child Orthop. 2016;10:627–632.
10. Cai Z, Li L, Zhang L, Ji S, Zhao Q. Dynamic long leg casting fixation for treating 12- to 18-month-old infants with developmental dysplasia of the hip. J Int Med Res. 2017;45:272–281.
11. Cha SM, Shin HD, Shin BK. Long-term results of closed reduction for developmental dislocation of the hip in children of walking age under eighteen months old. Int Orthop. 2018;42:175–182.
12. Cıtlak 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. Drummond DS, O'Donnell J, Breed A, Albert MJ, Robertson WW. Arthrography in the evaluation of congenital dislocation of the hip. Clin Orthop Relat Res. 1989;243:148–156.
14. Farsetti P, Caterini R, Potenza V, Ippolito E. Developmental dislocation of the hip successfully treated by preoperative traction and medial open reduction: a 22-year mean follow-up. Clin Orthop Relat Res. 2015;473:2658–2669.
15. Gardner RO, Bradley CS, Howard A, Narayanan UG, Wedge JH, Kelley SP. The incidence of avascular necrosis and the radiographic outcome following medial open reduction in children with developmental dysplasia of the hip: a systematic review. Bone Joint J. 2014;96:279–286.
16. Herring JA. Developmental dysplasia of the hip. In: Herring JA (ed.). Tachdjian's pediatric orthopaedics. Saunders/Elsevier, Philadelphia, 2014, pp 483–579.
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. Kim HT, Kim JI, Yoo CI. Acetabular development after closed reduction of developmental dislocation of the hip. J Pediatr Orthop. 2000;20:701–708.
19. Li Y, Guo Y, Li M, Zhou Q, Liu Y, Chen W, Li J, Canavese F, Xu H; Multi-center Pediatric Orthopedic Study Group of China. Acetabular index is the best predictor of late residual acetabular dysplasia after closed reduction in developmental dysplasia of the hip. Int Orthop. 2018;42:631–640.
20. Li Y, Guo Y, Shen X, Liu H, Mei H, Xu H, Canavese F; Chinese Multi-center Pediatric Orthopedic Study Group (CMPOS). Radiographic outcome of children older than twenty-four months with developmental dysplasia of the hip treated by closed reduction and spica cast immobilization in human position: a review of fifty-one hips. Int Orthop. 2019;43:1405–1411.
21. Li Y, Liu H, Guo Y, Xu H, Xun F, Liu Y, Yuan Z, Li J, Pereira B, Canavese F; Chinese Multi-center Pediatric Orthopaedic Study Group (CMPOS). Variables influencing the pelvic radiological evaluation in children with developmental dysplasia of the hip

managed by closed reduction: a multicentre investigation. Int Orthop. 2020;44:511–518.
22. Okano K, Yamada K, Takahashi K, Enomoto H, Osaki M, Shindo H. 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.
23. Omeroğlu H, Tumer Y. Çocuklarda Kalçanın Sık Görülen Hastalıkları. In: Çullu E (ed.). Çocuk Ortopedisi. Bayçınar Tıbbi Yayıncılık, İstanbul, 2012, pp 149–187.
24. 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;52:81–86.
25. Pollet V, Van Dijk L, Reijman M, Castelein RMC, Sakkers RJB. Long-term outcomes following the medial approach for open reduction of the hip in children with developmental dysplasia. Bone Joint J. 2018;100:822–827.
26. Sankar WN, Gornitzky AL, Clarke NMP, Herrera-Soto JA, Kelley SP, Matheney T, Mulpuri K, Schaeffer EK, Upasani VV, Williams N, Price CT; International Hip Dysplasia Institute. Closed reduction for developmental dysplasia of the hip: Early-term results from a prospective, multicenter cohort. J Pediatr Orthop. 2019;39:111–118.
27. 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.
28. Shin CH, Yoo WJ, Park MS, Kim JH, Choi IH, Cho TJ. Acetabular remodeling and role of osteotomy after closed reduction of developmental dysplasia of the hip. J Bone Joint Surg Am. 2016;98:952–957.
29. Tennant SJ, Eastwood DM, Calder P, Hashemi-Nejad A, Catterall A. A protocol for the use of closed reduction in children with developmental dysplasia of the hip incorporating open psoas and adductor releases and a short-leg cast: Mid-term outcomes in 113 hips. Bone Joint J. 2016;98:154–1553.
30. Tennant SJ, Hashemi-Nejad A, Calder P, Eastwood DM. Bilateral developmental dysplasia of the hip: does closed reduction have a role in management? Outcome of closed and open reduction in 92 hips. J Pediatr Orthop. 2019;39:264–271.
31. Terjesen T. Long-term outcome of closed reduction in late-detected hip dislocation: 60 patients aged six to 36 months at diagnosis followed to a mean age of 58 years. J Child Orthop. 2018;12:369–374.
32. Yorgancıgil H, Aslan A. Comparison of the clinical and radiological outcomes of open reduction via medial and anterior approach in developmental dysplasia of the hip. Eklem Hastalik Cerrahisi. 2016;27:74–80.
33. Zamzam MM, Kremli MK, Khoshhal KI, Abak AA, Bakarman KA, Alsiddiky AM, Alzain KO. Acetabular cartilaginous angle: a new method for predicting acetabular development in developmental dysplasia of the hip in children between 2 and 18 months of age. J Pediatr Orthop. 2008;28:518–523.

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