Joint Diseases and Related Surgery

Jt Dis Relat Surg
2023;34(3):605-612

ORIGINAL ARTICLE

Total hip arthroplasty in patients with coxarthrosis due to developmental dysplasia of the hip: Is fixation of the subtrochanteric osteotomy necessary?

Hakan Atalar, MD[1], Alim Can Baymurat, MD[1], İbrahim Kaya, MD[2], Mehmet Ali Tokgöz, MD[1], Tolga Tolunay, MD[1], Şefik Murat Arikan, MD[1]

[1]Department of Orthopedics and Traumatology, Gazi University Faculty of Medicine, Ankara, Türkiye
[2]Department of Orthopedics and Traumatology, Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Ankara, Türkiye

ABSTRACT

Objectives: This study aims to analyze the clinical, functional, and radiographic results of patients with Crowe type 4 developmental dysplasia of the hip (DDH) sequelae undergoing cementless total hip arthroplasty (THA) with transverse subtrochanteric shortening osteotomy without fixation at the osteotomy site.

Patients and methods: Between March 2013 and February 2020, a total of 42 hips of 34 patients (8 males, 26 females; mean age: 50.7±11.7 years; range, 27 to 76 years) with Crowe type 4 DDH treated with subtrochanteric shortening osteotomy combined with primary cementless THA were retrospectively analyzed. Each case was evaluated to the Harris Hip Score (HHS). Crowe classification, location of the rotation center of hip, loosening of the implants, and union at the osteotomy line were evaluated radiologically.

Results: The mean follow-up was 57.9±31.5 (range, 24 to 192) months. The mean interval to complete bone union in 40 hips (95%) after surgery was 3.5±0.9 (range, 2 to 6) months. The mean preoperative HHS scores of the patients was 35.6±6.86, while the scores increased to 91.53±5.41 at the final follow-up ($p<0.001$).

Conclusion: Our study results suggest that excellent clinical and radiological results can be obtained in Crowe type 4 dysplastic hips in patients undergoing THA with the rectangular femoral component and transverse shortening osteotomy technique, without fixation at the osteotomy site.

Keywords: Developmental dysplasia of the hip, rectangular femoral component, total hip arthroplasty, transverse subtrochanteric shortening osteotomy.

Total hip arthroplasty (THA) is a technically complex and difficult surgical procedure in patients with sequelae of developmental dysplasia of the hip (DDH) due to anatomic abnormalities, biomechanical changes, and advanced soft tissue contractures.[1,2] One of the most important steps during the surgical procedure is to transfer the hip to the anatomic center of rotation and to restore the functions of the abductor muscles. Anatomic hip center restoration often requires limb lengthening of >4 cm, which increases the risk of neurological injury.[3,4] A femoral shortening osteotomy is often required in patients classified as Crowe type 3-4 to safely place the hip in the true acetabulum and preserve neurovascular structures.[2,5]

Various osteotomy techniques which can be performed from the greater trochanter, lesser trochanter, and subtrochanteric regions have been described in the literature. Although oblique, double chevron, and step-cut osteotomy techniques contribute to stability, transverse osteotomies still remain popular, as they allow simultaneous correction

Received: March 06, 2023
Accepted: May 04, 2023
Published online: August 21, 2023

Correspondence: İbrahim Kaya, MD. Dr. Abdurrahman Yurtaslan Ankara Onkoloji Eğitim ve Araştırma Hastanesi Ortopedi ve Travmatoloji Kliniği, 06200 Yenimahalle, Ankara, Türkiye.

E-mail: drkayaibrahim@gmail.com

Doi: 10.52312/jdrs.2023.1091

Citation: Atalar H, Baymurat AC, Kaya İ, Tokgöz MA, Tolunay T, Arikan ŞM. Total hip arthroplasty in patients with coxarthrosis due to developmental dysplasia of the hip: Is fixation of the subtrochanteric osteotomy necessary?. Jt Dis Relat Surg 2023;34(3):605-612. doi: 10.52312/jdrs.2023.1091.

of femoral anteversion, they are relatively easier techniques, and have similar complication rates.[6,7] Although neurovascular problems can be avoided by performing a femoral shortening osteotomy, ensuring adequate union after osteotomy has remained a problem. Fixation methods such as plate, cable, and strut graft are used for fixation in femoral shortening osteotomy.[8-10]

Although several techniques have been reported in the literature to provide successful results for joint replacement and subtrochanteric osteotomy fixation, the necessity of internal fixation after osteotomy is still a matter of debate. In the present study, we aimed to analyze the clinical, functional, and radiographic results of patients with Crowe type 4 DDH sequelae who underwent cementless THA with transverse subtrochanteric shortening osteotomy without fixation at the osteotomy site.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Gazi University Faculty of Medicine,, Department of Orthopedics and Traumatology between March 2013 and February 2020. Clinical and radiological data of a total of 50 hips of 41 patients with Crowe type 4 DDH treated with subtrochanteric shortening osteotomy combined with primary cementless THA were reviewed. Inclusion criteria were as follows: having a diagnosis of neglected total hip joint dislocation treated with a cementless rectangular femoral component and femoral shortening osteotomy without additional fixation or grafting at the osteotomy site, and a follow-up period of at least 24 months. Exclusion criteria included the presence of another disease that may have a negative effect on union, or incomplete clinical and radiological data. Finally, a total of 42 hips of 34 patients (8 males, 26 females; mean age: 50.7±11.7 years; range, 27 to 76 years) were included in the study.

Demographic data of the patients, surgical side, properties of the implanted materials, acetabular insufficiency status, amount of femoral shortening, and follow-up period were recorded. Each case was evaluated in terms of pain and degree of disability, limitation in hip joint range of motion, limb length discrepancy, and limitation in walking and performing daily living activities according to the Harris Hip Score (HHS). Crowe classification, location of the rotation center of the hip, loosening of the implants, and union at the osteotomy line were evaluated radiologically.

After examining the clinical notes and radiographs of the patients, osteotomy union status and complications were noted. Bone union was defined as the presence of mature bone bridging at the osteotomy site and was evaluated on direct radiographs (Figures 1, 2, 3). Aseptic loosening was defined as lucency >2 mm at metal-bone interface, >1 cm subsidence and varus tilting of the femoral component, acetabular component migration or change in position/inclination. Complications were defined as deep infection, dislocation, neurological injury, intraoperative fracture, periprosthetic fracture, revision from any cause, or death from disease.

Surgical technique

All surgeries were performed by a single surgeon. All patients were operated in the supine position with the hip direct lateral approach (Hardinge). A femoral neck osteotomy was performed, followed by a shortening subtrochanteric osteotomy to facilitate localization of the true acetabulum. The acetabulum was initially prepared using small reamers, which were gradually increased to prepare with the largest possible reamer. After completion of the acetabular preparation, a press-fit cup was placed at approximately 40° to 45° abduction and 15° to 30° anteversion and 2 or 3 screws were placed to increase stability. In patients with superior wall defects, the autograft harvested from the femoral head was placed superolateral to the acetabulum and fixed with cannulated screws. After the acetabulum was completed, preparation of the proximal femoral canal was started, and reaming was continued until maximum cortical contact was obtained. Prophylactic cerclage wire was applied to some patients to prevent intraoperative fractures. The amount of bone excision was, then, determined by overlapping the proximal fragment and the distal fragment, which would equalize the length of both lower extremities under manual traction. The bone of the pre-determined length from the distal part was, then, osteotomized, the distal femoral medulla was reamerized again, and the femoral component was implanted (Figure 4). No additional fixation material was used in the osteotomy line and no grafting was performed. The hip was reduced and its stability against leg length, offset and dislocation was evaluated intraoperatively clinically and radiologically. Alloclassic® Zweymüller (Zimmer Biomet, IN, USA) rectangular section femoral component and ceramic-on-ceramic or ceramic-on-polyethylene acetabular component (Trilogy®; Zimmer Biomet, IN, USA) were used in all patients.

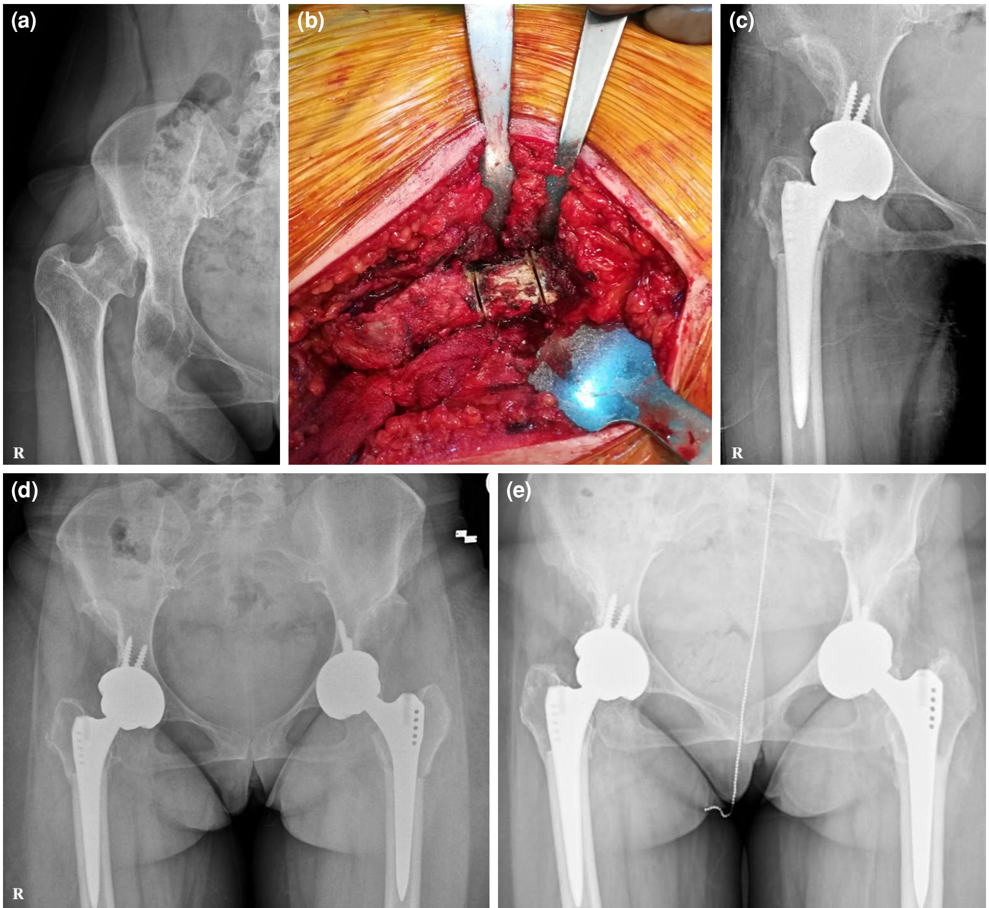

FIGURE 1. (a) Preoperative radiograph of bilateral developmental dysplasia of the hip in a 37-year-old woman. **(b)** Intraoperative view of transverse subtrochanteric osteotomy preparation. **(c)** Early postoperative radiographic image. **(d)** Postoperative radiographic image at five-month follow-up. **(e)** Postoperative radiographic image of Crowe type 4 right hip at 3.5-year follow-up.

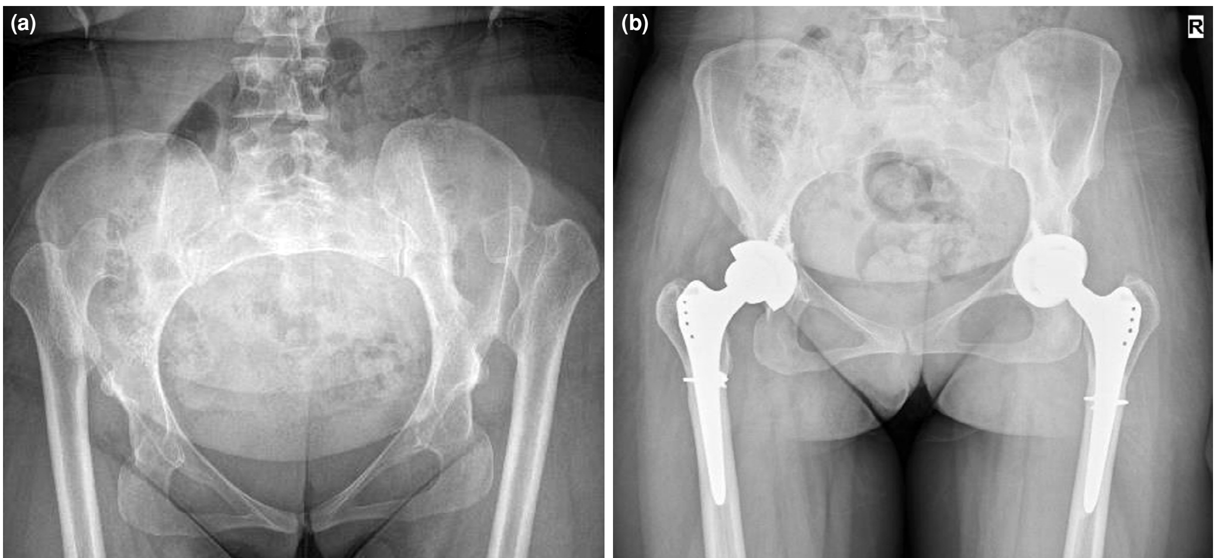

FIGURE 2. (a) Preoperative radiograph of bilateral high dislocation in a 33-year-old woman. **(b)** Postoperative radiographic image of right hip at two years and left hip at 2.5 years follow-up.

FIGURE 3. (a) Preoperative and **(b)** early postoperative and **(c)** 1.5-month. and **(d)** 3-month and **(e)** 5-month radiographies of a dysplasia of the hip type 4 patient.

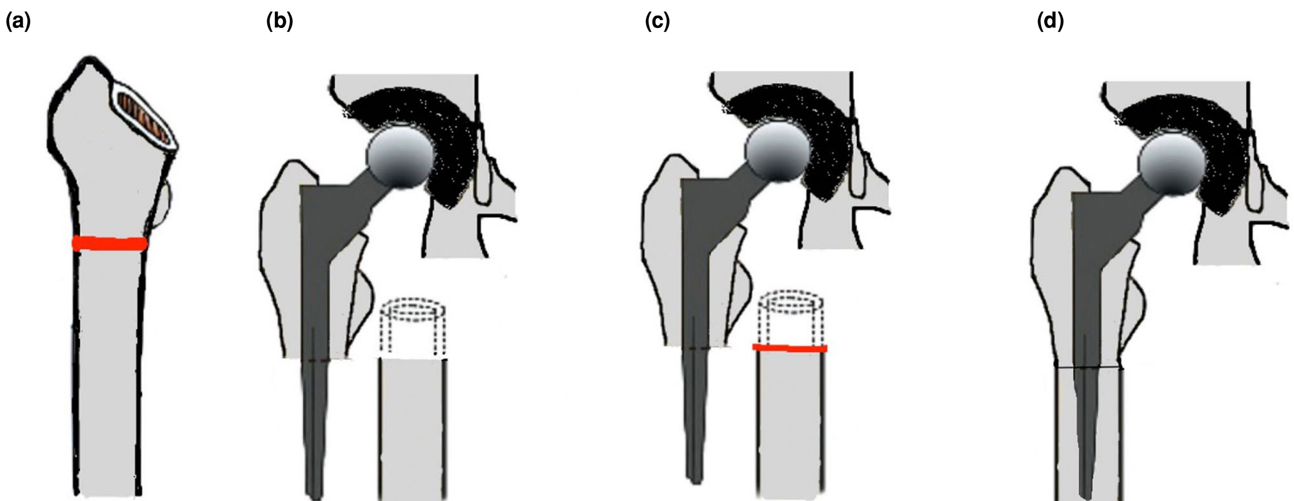

FIGURE 4. (a) Proximal transverse osteotomy line. **(b)** Preparation of the proximal femoral canal. **(c)** Distal transverse osteotomy line. **(d)** The osteotomy is transfixed by the rectangular femoral component, and the hip is reduced.

Postoperative care

The patients applied with only implants for acetabular reconstruction were mobilized with full weight-bearing on the first day after surgery, while full weight-bearing was avoided for six weeks in patients treated with grafts due to acetabular defects. Abductor and extensor strengthen muscle exercises were recommended for all patients.

Statistical analysis

Statistical analysis was performed using the IBM SPSS for Windows version 23.0 software (IBM Corp., Armonk, NY, USA). Continuous variables were expressed in mean ± standard deviation (SD) or median (min-max), while categorical variables were expressed in number and frequency. As the data did not conform to normal distribution, non-parametric tests were applied. The Wilcoxon signed-rank test was used to compare preoperative, and final follow-up data sets. The 10-year revision-free survival was calculated using the Kaplan-Meier method. A p value of <0.05 was considered statistically significant.

RESULTS

The mean follow-up was 57.9±31.5 (range, 24 to 192) months. The mean amount of femoral shortening performed during surgery was calculated as 2.94±0.41 (range, 2 to 4) cm and the mean interval to complete bone union in 40 hips (95%) after surgery was calculated as 3.5±0.9 (range, 2 to 6) months. Acetabular grafting was required in eight hips (19.1%) due to superolateral insufficiency (Table I). The sizes and materials of the components used are shown in Table II.

After femoral shortening osteotomy, non-union was observed in two hips (4.8%), and delayed union (>4 months) was observed in 11 hips (26.2%). An intraoperative fracture (2.4%) of the proximal femur occurred during surgery and aseptic loosening (2.4%) was observed in two separate patients. Two hips of two different patients with size 22 femoral head developed hip dislocation (4.8%) in the second and third weeks postoperatively and closed reduction was performed. In the postoperative period, no clinically important leg length discrepancy, Trendelenburg gait pattern, deep infection, or deep vein thrombosis were observed in any of the patients (Table III).

In the postoperative period, revision surgery was performed in one patient due to periprosthetic fracture 12 months after surgery and in one patient due to acetabular aseptic loosening 18 months later. According to the Kaplan-Meier survival analysis, the overall 10-year survival rate of THA was 95%

TABLE I
Demographic and clinical data of patients

	n	%	Mean±SD	Range
Age (year)			50.7±11.7	27-76
Sex				
Male	8	23.5		
Female	26	76.5		
Side				
Right	9	26.5		
Left	17	50		
Bilateral	8	23.5		
Femoral shortening (cm)			2.94±0.41	2-4
Acetabular grafting	8	19		
Follow-up (month)			57.87±31.51	24-192
Osteotomy union period (month)			3.46±0.85	2-6
Union	29	69.1		
Delayed	11	26.1		
Non-union	2	4.8		
Preoperative HHS			35.6±6.86	
Postoperative HHS			91.53±5.41	

SD: Standard deviation; HHS: Harris hip score.

TABLE II
Frequency and distribution of materials and sizes of the components

Component	Size	n	%
Femoral	01	15	35.7
	0	7	16.7
	1	3	7.1
	2	7	16.7
	3	5	11.9
	4	1	2.4
	5	3	7.1
	6	1	2.4
Acetabular	40	1	2.4
	42	5	11.9
	44	6	14.3
	46	25	59.5
	48	5	11.9
Head	22	7	16.6
	28	30	71.4
	32	5	11.9

TABLE III
Complications

	n	%
Intraoperative femur fracture	1	2.4
Dislocation	2	4.8
Superficial infection	1	2.4
Aseptic loosening	1	2.4
Periprosthetic femur fracture	1	2.4
Non-union	2	4.8
Heterotopic ossification	1	2.4
Total	9	2.14

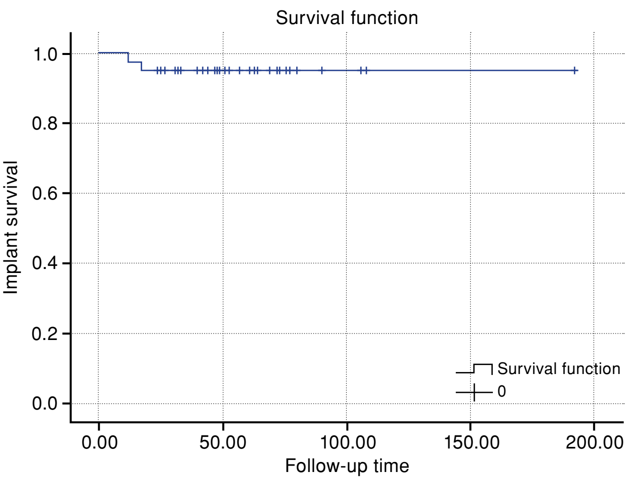

FIGURE 5. Kaplan-Meier survival analysis for implant systems.

for the whole system (95% confidence interval [CI]: 171.19-195.11) in Crowe type 4 DDH (Figure 5).

While the mean HHS scores of the patients was 35.6±6.86 before surgery, this increased to 91.53±5.41 at the final follow-up (p<0.001). When the mean HHS of patients with delayed union and non-union (91.50±4.04) and patients with union in time (91.57±7.51) were compared, no statistically significant difference was observed (p=0.969).

DISCUSSION

In the present study, we analyzed the clinical, functional, and radiographic results of patients with Crowe type 4 DDH sequelae who underwent cementless THA with transverse subtrochanteric shortening osteotomy without fixation at the osteotomy site. Our study results showed satisfactory outcomes of THA with a cementless rectangular femoral component performed combined with femoral shortening osteotomy in the treatment of Crowe type 4 DDH. Although no fixation material or bone graft was used in the osteotomy site of any of the patients, sufficient stability was achieved with rectangular and tapered femoral components in this patient group and 95.2% bone union was observed.[11]

Bone union problems of the osteotomy site are among the important problems encountered after femoral shortening osteotomy. Plate-screw and grafting combinations are used to ensure full union after osteotomy. Fixation of the osteotomy line makes a significant contribution to the preservation of stability and femoral anteversion, when proximally fixed femoral component designs are used. Non-union has been reported more frequently in case series of reconstructions using cemented femoral components.[12] In a study conducted by Akiyama et al.,[13] the results were reported of 15 hips of 11 patients who underwent cemented THA with subtrochanteric femoral shortening transverse osteotomy, and non-union was observed in 20% of the patients. In previous studies using cementless straight-shaped femoral components, grafting and internal fixation of the osteotomy have been recommended. In a study conducted by Yalcin et al.[5] including 44 hips of 31 patients, internal fixation was required due to the intraoperative instability in the osteotomy line of 10 patients, and non-union was observed in five patients in the postoperative period. In studies reporting the results of internal fixation with plate-screw, the non-union rate was 5.5% by Charity et al.,[14] 3.3% by Çağlar et al.,[8] and 5.4% by Sofu et al.[9] Thanks to its design, the rectangular femoral stem we use provides press-fit involvement in the distal of the osteotomy area and good stability against both rotational and bending stresses. Studies reporting lower rates of union in the literature have shown that non-unions are mostly due to rotational instability. Erdem et al.[7] also reported in their study that the rectangular femoral stem provided sufficient stability of the osteotomy and that they achieved complete union in all patients. We believe that the reason for the higher union rates compared to our study is the autograft and cable fixation applied to the osteotomy line.

Another method used for the fixation of the osteotomy line is the graft-cable combination. The clinical results of 67 hips of 50 patients with a minimum of 10 years follow-up reported by Çaylak et al.[6] showed non-union in only two patients. Altay et al.[10] presented the results of 41 hips of 37 patients, and instability in the osteotomy site was observed in 16 patients after the insertion of the femoral component, and complete union was achieved in all patients using fixation with graft-cable.

It has also been reported that the need for internal fixation can be eliminated by placing a graft in the distal part of the medullary canal from the osteotomy and changing the femoral component type. Togrul et al.[15] presented the results of implantation in the medullary canal of bone pegs prepared from the resected femoral segment for femoral fixation, which provided excellent rotational stability, eliminating the need for additional osteosynthesis regardless of the femoral component design. Of 33 Crowe type 4 DDH patients treated with a cementless modular femoral component with a transverse subtrochanteric shortening osteotomy, the minimum 10-year results were presented and complete union was achieved in all patients.[16]

Another type of implant in which osteotomy stability and femoral anteversion can be preserved is the cementless rectangular femoral component with distal fixation. Kayaalp et al.[17] presented the results of 50 hips of 41 patients using cementless rectangular femoral components without any additional extramedullary fixation. An excellent functional score was achieved in 68% of patients, while non-union was observed in only one patient. The overall complication rate of that series was 32%. In the current study, excellent results were achieved in 81% of the patients, the complication rate was reported as 21.4%, and non-union was observed in only two patients. In the opinion of the current authors, fixation of the osteotomy line is not required, if implant involvement is achieved in the proximal and distal femoral fragments. In the two patients without union in this study, the postoperative HHS scores were good and excellent, and neither had any clinical findings. We believe that our union rates are high, as a stable fixation in the osteotomy line is ensured with the rectangular femoral component and full weight-bearing is given to the patients in the early period.

Considering the HHS scores of patients with high hip dislocation undergoing THA with femoral shortening osteotomy, scores of 83 to 94 have been reported on average.[18] In the current study, there was calculated to be a significant improvement in the scores and the mean HHS score was 91.53±5.41 at the final follow-up. The patients with a functional score that was not excellent were those who experienced dislocation and underwent component revision. During evaluation of the two patients with non-union, the hip was painless, osteotomy site was stable, and excellent functional scores were obtained and, therefore, no additional surgical intervention was performed. When the early postoperative direct radiographs of the patients with non-union were examined, full contact could not be achieved in the osteotomy line.

The main limitations to this study are its single-center, retrospective design, relatively small sample size, lack of a comparison group, and the lack of assessment of spinopelvic conditions.

In conclusion, our study results suggest that satisfactory clinical and radiological results can be obtained in Crowe type 4 dysplastic hips in patients undergoing THA with the rectangular femoral component and transverse shortening osteotomy technique, without fixation at the osteotomy site. In addition, if full cortical contact can be achieved in the osteotomy area, union can be successfully achieved without grafting. The excellent clinical results are clear evidence that primary and secondary stability for the osteotomy site, including rotatory instability, can be achieved with rectangular section femoral components.

Ethics Committee Approval: The study protocol was approved by the Medicine Faculty of Gazi University Ethics Committee (date: 22.02.2022 no: 04). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept and design: H.A., Ş.M.A.; Data collection and/or processing: İ.K., M.A.T.; Analysis and/or interpretation and control/supervision: H.A., A.C.B.; Literature review: H.A., A.C.B., İ.K.; Writing the article: H.A., İ.K., M.A.T.; Critical review: T.T., Ş.M.A.; References and fundings: H.A., Ş.M.A.; Materials: M.A.T.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Xiong A, Li G, Liu S, Chen Y, Xu C, Weng J, et al. Anterolateral approach may be superior to posterolateral approach in controlling postoperative lower limb discrepancy in primary total hip arthroplasty: A single-center, retrospective cohort study. Jt Dis Relat Surg 2023;34:32-41. doi: 10.52312/jdrs.2022.763.
2. Bao N, Meng J, Zhou L, Guo T, Zeng X, Zhao J. Lesser trochanteric osteotomy in total hip arthroplasty for treating CROWE type IV developmental dysplasia of hip. Int Orthop 2013;37:385-90. doi: 10.1007/s00264-012-1758-4.
3. Huang ZY, Liu H, Li M, Ling J, Zhang JH, Zeng ZM. Optimal location of subtrochanteric osteotomy in total hip arthroplasty for crowe type IV developmental dysplasia of hip. BMC Musculoskelet Disord 2020;21:210. doi: 10.1186/s12891-020-03248-8.
4. Park MS, Kim KH, Jeong WC. Transverse subtrochanteric shortening osteotomy in primary total hip arthroplasty for patients with severe hip developmental dysplasia. J Arthroplasty 2007;22:1031-6. doi: 10.1016/j.arth.2007.05.011.
5. Yalcin N, Kilicarslan K, Karatas F, Mutlu T, Yildirim H. Cementless total hip arthroplasty with subtrochanteric transverse shortening osteotomy for severely dysplastic or dislocated hips. Hip Int 2010;20:87-93. doi: 10.1177/112070001002000113.
6. Caylak R, Ors C, Togrul E. Minimum 10-Year results of cementless ceramic-on-ceramic total hip arthroplasty performed with transverse subtrochanteric osteotomy in crowe type IV hips. J Arthroplasty 2021;36:3519-26. doi: 10.1016/j.arth.2021.05.035.
7. Erdem Y, Bek D, Atbasi Z, Neyisci C, Yildiz C, Basbozkurt M. Total hip arthroplasty with rectangular stems and subtrochanteric transverse shortening osteotomy in Crowe type IV hips: A retrospective study. Arthroplast Today 2019;5:234-42. doi: 10.1016/j.artd.2019.03.002.
8. Çağlar Ö, Özdemir E, Tokgözoğlu AM, Atilla B. Use of proximal humerus plates for the fixation of the subtrochanteric femoral shortening osteotomy during total hip arthroplasty for Crowe type IV developmental dysplasia of the hip patients. Jt Dis Relat Surg 2020;31:306-11. doi: 10.5606/ehc.2020.73078.
9. Sofu H, Kockara N, Gursu S, Issin A, Oner A, Sahin V. Transverse subtrochanteric shortening osteotomy during cementless total hip arthroplasty in crowe type-III or IV developmental dysplasia. J Arthroplasty 2015;30:1019-23. doi: 10.1016/j.arth.2015.01.045.
10. Altay M, Demirkale İ, Çatma MF, Karaduman M. Results of crowe type IV developmental dysplasia of hip treated by subtrochantric osteotomy and total hip arthroplasty. Indian J Orthop 2018;52:374-9. doi: 10.4103/ortho.IJOrtho_445_16.
11. Atik OŞ. Which articles do the editors prefer to publish? Jt Dis Relat Surg 2022;33:1-2. doi: 10.52312/jdrs.2022.57903.
12. Gong S, Xu W, Wang R, Liu S, Han L, Chen G, et al. The causes and management of nonunion of femoral subtrochanteric shortening osteotomy in a THA patient: A case report. BMC Musculoskelet Disord 2019;20:203. doi: 10.1186/s12891-019-2612-2.
13. Akiyama H, Kawanabe K, Yamamoto K, Kuroda Y, So K, Goto K, et al. Cemented total hip arthroplasty with subtrochanteric femoral shortening transverse osteotomy for severely dislocated hips: Outcome with a 3- to 10-year follow-up period. J Orthop Sci 2011;16:270-7. doi: 10.1007/s00776-011-0049-z.
14. Charity JA, Tsiridis E, Sheeraz A, Howell JR, Hubble MJ, Timperley AJ, et al. Treatment of Crowe IV high hip dysplasia with total hip replacement using the Exeter stem and shortening derotational subtrochanteric osteotomy. J Bone Joint Surg [Br] 2011;93:34-8. doi: 10.1302/0301-620X.93B1.24689.
15. Togrul E, Ozkan C, Kalaci A, Gülşen M. A new technique of subtrochanteric shortening in total hip replacement for Crowe type 3 to 4 dysplasia of the hip. J Arthroplasty 2010;25:465-70. doi: 10.1016/j.arth.2009.02.023.
16. Sun C, Zhang Y, Li LT, Ding H, Guo T, Zhao JN. Long-term outcomes of total hip arthroplasty with transverse subtrochanteric shortening osteotomy and modular stem in crowe IV developmental dysplasia. J Arthroplasty 2021;36:630-5. doi: 10.1016/j.arth.2020.08.031.
17. Kayaalp ME, Can A, Erdogan F, Ozsahin MK, Aydingoz O, Kaynak G. Clinical and radiological results of crowe type 3 or 4 dysplasia patients operated on with total hip arthroplasty using a cementless rectangular femoral component without fixating or grafting the transverse osteotomy site. J Arthroplasty 2020;35:2537-42. doi: 10.1016/j.arth.2020.04.045.
18. Shi XT, Li CF, Han Y, Song Y, Li SX, Liu JG. Total hip arthroplasty for crowe type IV hip dysplasia: Surgical techniques and postoperative complications. Orthop Surg 2019;11:966-73. doi: 10.1111/os.12576.