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ORIGINAL STUDY

Long-term results of total hip arthroplasty with transverse subtrochanteric shortening osteotomy in developmental high dislocation of the hip

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In this study we aim to evaluate the functional and clinical results and complications of developmental high-dislocated hips after subtrochanteric transverse shortening osteotomy. The femoral osteotomies all fixed axially and rotationally by rectangular cementless stem. The acetabular components placed to the true acetabulum. Results of 50 primary cementless total hip arthroplasties in 28 patients all having Crowe 4 high dislocations were evaluated. Arthroplasties were performed in combination with a subtrochanteric transverse shortening osteotomy and Zweymüller femoral stem without any fixation instruments for the osteotomy. The acetabular component placed at the level of anatomic hip center.

The mean follow-up was 102 months (72-132 months). The mean Harris Hip Score increased from 24.03 to 82.88 points at the time of final follow-up. Ten of the 50 hips had early or late minor complications and/or reoperations including debridement and irrigation. None of the subtrochanteric osteotomies were followed for nonunion or malunion, and there were no complications concerning the femoral site throughout the postoperative follow-up period.

Keywords : Hip ; subtrochanteric ; osteotomy ; developmental ; dislocation.

INTRODUCTION

Total hip arthroplasty (THA) has certain technical difficulties in patients with developmental high dislocation of the hip. The distorted anatomy may cause abnormal neurovascular structures, soft tissue contractures, abnormal location of the hip center, leg length discrepancy, and increased anteversion of the femoral neck-shaft angle *(2,5)*. Proximal displacement of the femoral head leads to not only more horizontal direction of the abductor muscles, but also elongation of the abductor muscles. Bone structure of the true and false acetabulum and iliac crest is deficient, shallower and thinner *(4,5)*.

The successful placement and positioning of the acetabular cup requires an anatomic reduction without causing excessive compressive loads across the hip joint. In order toachieve this, it is

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recommended that THA should be combined with femoral shortening *(16,26)*. The purpose of our study was to evaluate the functional and clinical results of developmental high-dislocated hips after subtrochanteric transverse shortening osteotomy fixed axially and rotationally by the cementless femoral stems.

MATERIALS AND METHODS

We evaluated 50 primary cementless total hip arthroplasties in 28 patients (26 females, 2 males) who had Crowe 4 or Hartofilakidis type 3 hips (Figure 1). The mean age was 38.6 ± 11.9 years. The dispersion of the hips were ; 32 metal-on-polyethylene, 16 ceramic-on-ceramic, and 2 metal-on-metal bearings. Subtrochanteric transverse shortening osteotomy was fixed with Zweymüller femoral stem without any additional fixation instruments. All the acetabular components were placed at the level of anatomic hip center. Twenty-two patients were operated bilaterally. Minimum interval between operations was 3 months for bilateral cases. Twelve patients had undergone previous femoral, pelvic or periacetabular osteotomies. The type and size of the prosthesis were determined by using templates on 1 : 1,05 scale radiographs preoperatively. Trilogy acetabular system and alloclassic Zweymüller femoral stems (Zimmer, Warsaw, IN), Biomet Exceed ABT acetabular cups (Warsaw, IN), and PPF femoral stems (Warsaw, IN) were used. 22.2, 28, 32 mm femoral heads were used in all bearings.

The direct anterolateral approach was performed in a supine position for all patients. Reaming was performed according to the anterior-posterior diameter of the acetabulum. In cases where the superior segmental defect affected the stability of the cup, a graft obtained from the femoral head was used to fill the defect. In high dislocations, a subtrochanteric shortening osteotomy was performed, if preoperative templating proposed that placing the acetabular cup in the true acetabulum would result in lengthening more than 2 cm. The length of the resection was calculated by the vertical distance between teardrop lines which was drawn through the edge of teardrops on preoperative AP x-rays. Alternatively, the resection amount was also determined intraoperatively. After subtrochanteric osteotomy and, replacing the acetabular cup and the femoral trial stem, the hip was reduced and the length of overlapped femoral bone was measured. This overlapping length was accepted as the amount of shortening required. Since the best bone stock was present in the posterior acetabulum, 36 mm and 38 mm small reamers were directed posteriorly, increasing gradually in diameter. Cementless acetabular cup stability was augmented with screws. The femoral stem was passed through proximal and distal part of the femur and press-fit stabilisation was achieved (Figure 2A-2B). The distal fixation remained more than 2 times the diameter of the distal osteotomy site which usually corresponded to the isthmus. Stability of the osteotomy site was secured by cross-sectional geometry of the rectangular square femoral stem.

Figure 1. — Preoperative x-ray of 54 years old female patient's right hip with DDH Crowe type 4. The length of the resection was calculated by the vertical distance between teardrop lines drawn through the edge of teardrops. She had undergone right total hip artroplasty for her right hip previously.

Cefazolin 2 g was used for antibiotic prophylaxis which was given for 24 hours. Antiembolic stockings and low molecular weight heparin (LMWH) was used for deep venous thrombosis prophylaxis and LMWH was administered for 30 days. The patients were instructed to perform partial weight bearing using a walker for a minimum of 6 weeks. If no problem was observed during the first follow-up which was at the 6th postoperative weeks, the patient

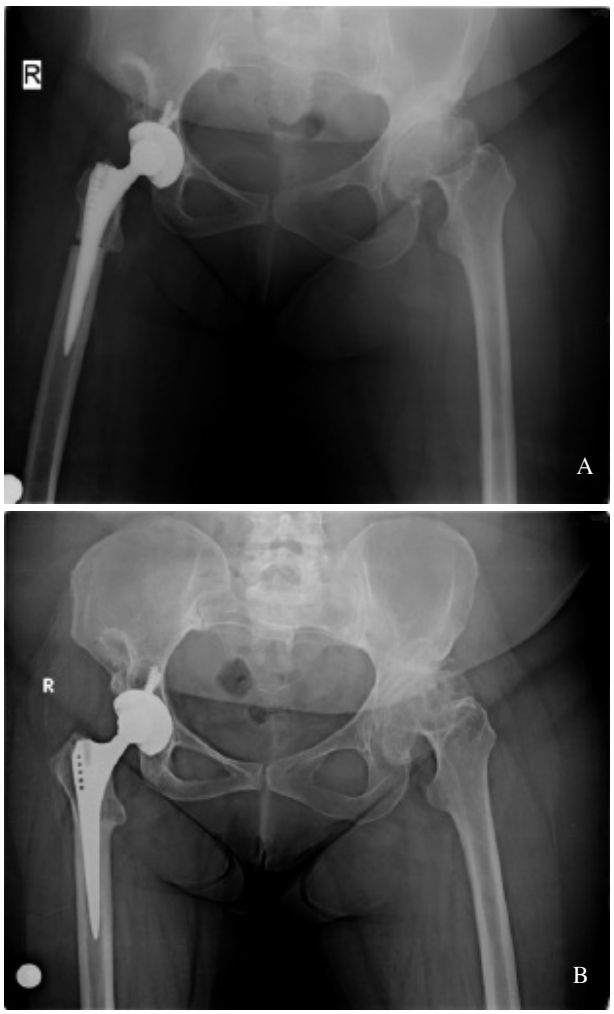

Figure 2. — A) Postoperative x-ray of the patient. The acetabulum was replaced in the anatomic position and rotational stability was achieved by rectangular design of the femoral stem. B) The x-ray of the same patient after 11 years follow-up. Note complete union with well fixed components.

was allowed to perform full weight bearing. Follow-up was done routinely at the week 6, as well as the months 3, 6, and 12 and then annually after ward from March 2006 to February 2017.

Preoperative and postoperative Harris Hip Scores (HHS) were calculated for each patient. Postoperative HHS scores were calculated at the last follow-up. Scores were evaluated as 90-100 (excellent), 80–89 (good), 70-79 (fair), and <70 (poor). Postoperative standing AP and lateral radiographs of the patient's operated hip were taken, and an independent observer evaluated these images. Callus formation at the osteotomy side, cortical continuity and absence of gaps between fragments were considered as union.

Statistical analyses were performed using the SPSS v.15 for Windows (SPSS Inc., Chicago, IL, USA). The variables were evaluated using visual (histograms, probability plots) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk test) to determine whether or not they are normally distributed. Descriptive analyses were presented using means and standard deviations for normally distributed variables (preoperative and postoperative Harris Hip Scores). Paired Student's t-test was used to compare the measurements at two time points (preoperatively and 12 months postoperatively) for HHS. A p-value of less than 0.05 was considered to show a statistically significant result.

RESULTS

Twenty-eight patients (50 hips) were monitored for a mean of 94.5 months (72-117 months). A statistically significant difference was found between preoperative and postoperative HHS (24.03 and 82.80, respectively ($p<0.05$)). Excellent results (90–100) were obtained in 11 patients, while good (80–89), fair (70-79), and poor results (<70) were achieved in 23,13, and 3 patients, respectively (Table 1). Excellent and good results were obtained in 34 (68%) of the 50 patients. The mean shortening

Table 1. — Postoperative results

Excellent	11
Good	23
Fair	13
Poor	3

No. of patients.

Table 2. — Summary of the complications.

Acetabular component aseptic loosening	1
Dislocation	2
Intraoperative femoral fracture	3
Sciatic neuropraxie	1
Heterotopic ossification	3

Number of hips (n=10).

length was 3 cm (range 2-4 cm). Final leg length discrepancy improved from 4.5 cm to 1.2 cm. There were no cases of nonunion and malunion at the femoral osteotomy sites.

Complications which developed in 10 of 50 hips are presented in Table 2. Intraoperative femoral fractures were seen in three hips. One of them was on the proximal part (trochanteric site), and the remaining two were on the distal femur. All were fixed by using cerclage wire and/or cables without any further complications. Heterotopic ossificatio Brooker type I was seen in three hips which were followed up without any further pain or complications. Revision surgery was performed in one patient for aseptic acetabular component loosening which has been revised and fixed with a larger in diameter acetabular component.

DISCUSSION

Total hip arthtoplasty is not only one of the most commonly performed orthopedic surgeries, but also the most effective surgery for Crowe 4 (Hartofilakidis type 3) hips *(21)*. A Porous-coated and press-fit acetabular cup was implanted in the true acetabulum in each patient. Literature proposes that aseptic loosening incidence is lower and fixation is better in porous-coated components placed by the press-fit method *(8,24)*. Accordingly, we placed a porous-coated acetabular cup using this method in the true acetabulum in each patient *(17,18)*.

Several shortening osteotomy methods for the femur have been described to avoid neurologic deficits in patients with coxarthrosis associated with developmental dislocated hips *(1,15)*. Subtrochanteric osteotomies can be performed as step-cut, oblique, transverse, or *Chevron* type *(12,22)*. Trochanteric osteotomy is especially recommended for hips with high dislocation as it provides better and safer exposure as well as reconstruction of both the acetabulum and femur *(9,22)*. We prefer subtrochanteric transverse osteotomy for hips with high dislocation since the trochanter major and abductor muscles are not damaged when this technique is performed. We achieved stability in rotation by means of a cementless prosthesis with a rectangular cross-section. Götze et al. reported that rotational stability could be secured by the cross-sectional geometry of the stem design *(9)*. The osteotomy site healed within 8 weeks without any complications in our cases. Direct lateral approach was preferred in all our patients which we believe that provides a better surgical exposure and relatively low dislocation risk.

In our study, the Harris hip score increased from a preoperative 24.03 to 82.88 postoperatively. These results are in accordance with the literature *(13,20)*. Complications occurred in 10 (20%) of the 50 hips in our study. Extreme distortion, narrow femoral canal, and anteversion are factors which caused difficulties with femoral stem placement in DDH *(10)*. The incidence of intraoperative femoral fracture ranges from 2.95% to 27.8% when cementless femoral components are used in primary THA *(11,14)*. Perka et al. treated 121 cases of DDH with Zweymüller stems, and the incidence of intraoperative fracture was 8% ; however, it was noted that an intraoperative fracture did not affect the clinical outcome *(18)*. Intraoperative femoral fracture was seen in three (6%) cases in our series. These fractures were fixated with cerclage and cables, and successful results were seen during postoperative follow-ups. The low incidence of intraoperative fracture in our study is attributed to careful preoperative planning. It is also reported placing the cup in the anatomic hip center position provides stable fixation. and maintains the abduction strength, and equalizes the leg lengths *(17,24)*. Sciatic nerve palsy (neuropraxia) was observed in one. Almost full neurologic recovery in 6 months was achieved by physiotherapy. Eskelinen et al. report that elongation should be less than 4 cm to avoid neurologic complications *(8)*. However, Eggli et al. have stated that the degree of elongation and incidence of neurological damage was not related and neural damage was mainly caused by direct or indirect mechanical trauma *(6)*. In our case, sciatic neuropraxia occurreddue to the inadequate shorthening. . In order to alleviate the tension on the sciatic nerve, we kept both hip and knee in 20 degrees flexed position for 2 days postoperatively. .

Union rates for the osteotomy sites were reported between 86% and 100% in the literature *(7,13)*. We did not detect any nonunion at the subtrochanteric

osteotomy site.. There were three (%6) postoperative superficial wound infections which were treated with antibiotics and healed eventually without any further complications.

There were several limitations in our study. First, the study was designed retrospectively and the number of patients were relatively small. However, we should consider that high dislocation in end stage osteoarthritis of the hip is a rare clinical condition. Prospective randomized studies with larger series and longer follow-ups are necessary to illuminate the effectiveness of rectangular designs for the patients who had undergone subtrochanteric osteotomies. Secondly, various types of implants were used for the patients and this mightaffect data homogenization.

CONCLUSION

Subtrochanteric shortening osteotomy and cementless total hip artroplasty for the treatment of Crowe type 4 developmental dysplasia of the hip is an effective surgery with high success rates. Although replacement of arthritic hips due to degenerative DDH is challenging, it remains the most reproducible and reliable procedure in alleviating the symptoms of advanced arthritis in this setting. Careful planning and specialised surgical considerations are needed throughout the spectrum of DDH cases, from mild to severe. Our current technique, cementlless THA is capable of producing good results. Complications can be minimised by adequate exposure, avoiding the over lengthening of the limb and implanting the components to the appropriate position.

REFERENCES

1. **Bao N, Meng J, Zhou L, *et al,*** Lesser trochanteric osteotomy in total hip arthroplasty for treating CROWE type IV developmental dysplasia of hip. *In.t Orthop.* 2013 ; 37 : 385-90.
2. **Charnley J, Feagin JA,** Low-friction arthroplasty in congenital subluxation of the hip. *Clin. Orthop. Relat. Res.* 1973 ; 91 : 98-113.
3. **Crowe JF, Mani VJ, Ranawat CS**. Total hip replacement in congenital dysplasia and dislocation of the hip. *J. Bone Joint Surg. Am.* 1979 ; 61 : 15-23.
4. **DeLee JG, Charnley J.** Radiological demarcation of cemented sockets in total hip replacement. *Clin. Orthop. Relat. Res.* 1976 ; 121 : 20-32.
5. **Dunn HK, Hess WE.,** Total hip reconstruction in chronically dislocated hips. *J. Bone Joint Surg. Am.* 1976 ; 58 : 838-45.
6. **Eggli S, Hankemayer S, Müller ME.** Nerve palsy after leg lengthening in total replacement arthroplasty for developmental dysplasia of the hip. *J. Bone Joint Surg. Br.* 1999 ; 81 : 843-845.
7. **Erdemli B, Yılmaz C, Atalar H, Güzel B, Cetin I.** Total hip arthroplasty in developmental high dislocation of the hip. *J. Arthroplasty* 2005 ; 20 : 1021-1028.
8. **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.
9. **Götze C, Winkelmann W, Gosheger G, Rödl R.** Is there a need of an additional extramedullary fixation in transverse subtrochanteric shortening in primary total hip arthroplasty for patients with severe hip dysplasia? Short-term experience in seven patients with congenital dislocation. *Z. Orthop. Unfall* 2007, 145 : 568-73.
10. **Hartofilakidis G, Stamos K, Karachalios T.** Treatment of high dislocation of the hip in adults with total hip arthroplasty. Operative technique and long-term clinical results. *J. Bone Joint Surg. Am.* 1998 ; 80 : 510-517.
11. **Jensen JS, Retpen JB.** Failures with the Judet noncemented total hip. *Acta Orthop. Scand.* 1987 ; 58 : 23-6.
12. **Kilicoglu OI, Turker M, Akgul T, Yazicioglu O.** Cementless total hip arthroplasty with modified oblique femoral shortening osteotomy in Crowe Type IV congenital hip dislocation. *J. Arthroplasty* 2013 ; 28 : 117-25.
13. **Krych AJ, Howard JL, Trousdale RT, CAbanela ME, Berry DJ.,** Total hip arthroplasty with shortening subtrochanteric osteotomy in Crowe type-IV developmental dysplasia. *J. Bone Joint Surg. Am.* 2009 ; 91 : 2213-2221.
14. **Muratli KS, Karatosun V, Uzun B, Celik S.,** Subtrochanteric shortening in total hip arthroplasty : bio-mechanical comparison of four techniques. *J. Arthroplasty*. 2014 ; 29 : 836-842.
15. **Neumann D, Thaler C, Dorn U.,** Femoral shortening and cementless arthroplasty in Crowe type 4 congenital dislocation of the hip. *Int. Orthop.* 2012 ; 36 : 499-503.
16. **Ollivier M, Abdel MP, Krych AJ, Trousdale RT, Berry D J.,** Long-Term Results of Total Hip Arthroplasty With Shortening Subtrochanteric Osteotomy in Crowe IV Developmental Dysplasia. *J. Arthroplasty* 2016 ; 31 : 1756-60.
17. **Pagnano W, Hanssen AD, Lewallen DG, Shaughnessy WJ.** The effect of superior placement of the acetabular component on the rate of loosening after total hip arthroplasty. *J. Bone Joint Surg. Am.* 1996 ; 78 : 1004-1014.
18. **Perka C, Fischer U, Taylor WR.** Developmental hip dysplasia treated with total hip arthroplasty with a straight stem and a threaded cup. *J. Bone Joint Surg. Am.* 2004 ; 86-A : 312.

19. **Queen RM, Appleton JS, Butler RJ** Total Hip Arthroplasty surgical approach does not alter postoperative gait mechanics one year after surgery. *PMR* 2014 ; 6 : 221-6.
20. **Reikeras O, Haaland JE, LEreim P.** Femoral shortening in total hip arthroplasty for high developmental dysplasia of the hip. *Clin. Orthop. Relat. Res.* 2010 ; 468 : 1949-1955.
21. **Sofu H, Sahin V, Gürsu S, Yildirim T, Issin A, Koçkara N.** Cementless total hip arthroplasty in patients with Crowe type-4 developmental dysplasia. *Hip In.* 2013 ; 23 : 472-477.
22. **Sofu H, Kockara N, Gursu S, Issin A, Oner A, Sahin V**. Tranverse subtrochanteric shortening osteotomy during cementless total hip arthroplasty in Crown type-III or IV developmental dysplasia. *J. Arthroplasty* 2015 ; 30 : 1019-23.
23. **Yildirim T, Guclu B, Karaguven D, Kaya A, Akan B, Cetin I**. Cementless total hip arthroplasty in developmental dysplasia of the hip with end stage osteoarthritis : 2-7 years' clinical results. *Hip Int.* 2016 ; 474 : 1028-37
24. **Yoder SA, Brand RA, Pedersen DR, O'Gorman TW.** Total hip acetabular component position affects component loosening rates. *Clin. Orthop. Relat. Res.* 1988 ; 228 : 79-87.