Original Article | Clinics in Orthopedic Surgery 2022;14:205-212 • https://doi.org/10.4055/cios21104

Step-Cut Subtrochanteric Osteotomy Combined with Total Hip Arthroplasty for Neglected Traumatic Hip Dislocations

Jatin Talwar, MS, Saumya Agarwal, MS*, Sarang Agarwal, MS, Loveneesh G. Krishna, MS, Ashish Rustagi, MS

Central Institute of Orthopaedics, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi,
**Department of Orthopaedics, Ravindra Nath Tagore Medical College, Udaipur, India*

Background: Total Hip Arthroplasty remains the standard treatment protocol for patients with neglected traumatic dislocations of the hip with arthritis. A total hip arthroplasty needs to be frequently combined with a subtrochanteric shortening femoral osteotomy to aid in the reduction of the hip joint in such cases. Still long-term stable implant fixation, rigid construct, and favorable functional outcome remain a challenge. In respect to subtrochanteric shortening osteotomy, various techniques have been described in the literature, including the step-cut, double chevron, transverse, and oblique osteotomies. Out of these types, a subtrochanteric step-cut osteotomy provides a better rotational stability and a larger surface of contact to aid in union. As there is a paucity in the literature regarding the step-cut osteotomy for traumatic dislocations of the hip, we designed this study to evaluate the outcomes of this procedure.

Methods: We prospectively evaluated 24 patients with neglected traumatic dislocations of the hip, who underwent total hip arthroplasty with a step-cut subtrochanteric shortening osteotomy using a long modular stem within a span of 4 years. The indications were severe pain and difficulty in walking and performing activities of daily living. Patients fulfilling the inclusion criteria were evaluated in terms of Harris Hip Score, leg length discrepancy, neurological status, union of the osteotomy, and implant stability.

Results: The mean Harris Hip Score significantly improved from 33.4 preoperatively to 89.2 postoperatively at the latest follow-up. At the final follow-up, all patients showed union at the osteotomy site and there were no cases of implant loosening or instability. No neurological complications were reported.

Conclusions: Total hip arthroplasty combined with a step-cut subtrochanteric femoral shortening osteotomy in patients with neglected dislocations of the hip was associated with good functional outcome and higher success rates in terms of stable implant fixation and union at the site of osteotomy.

Keywords: *Replacement arthroplasty, Total hip arthoplasty, Osteotomy, Hip dislocation*

Neglected traumatic dislocations of the hip in adults most commonly result from a high velocity trauma and the lack of an adequate treatment.[1] They remain a difficult treatment entity since both femoral and acetabular sides appear to be challenging owing to their altered anatomy. In dislocated hips, the femoral head articulates with the iliac bone and results in formation of a pseudoacetabulum. The force vector direction of abductor muscles, which is usually

Received June 29, 2021; Revised November 7, 2021;
Accepted November 7, 2021
Correspondence to: Jatin Talwar, MS
Central Institute of Orthopaedics, Vardhman Mahavir Medical College and Safdarjung Hospital, C-36, Sector-19, NOIDA-201301, Uttar Pradesh, India
Tel: +91-98-1166-6788
E-mail: talwarjatin@gmail.com

vertical, changes to horizontal, and the muscles become shortened and contracted.[2)]

Proximal displacement of the joint causes laxity and weakening of the abductors, leading to early abductor fatigue and insufficiency. The optimal surgical treatment for patients with high dislocations of the hip poses several challenges and may differ from person to person. The new center of rotation (COR) of the hip after cup placement determines the course of hip biomechanics, leg length, and femoral reconstruction. If the cup is placed in pseudoacetabulum, it may lead to high dislocation rates, persistent limp, and high rates of component loosening.[3)] The new COR should be restored optimally at the level of true acetabulum or at least within 1 cm of the anatomical hip center to ensure reduced hip contact stresses.[4)] To aid in the reduction of prosthetic hip joint, the femur needs to be shortened. To achieve this, different osteotomy techniques have been described in the literature. An intertrochanteric osteotomy can disrupt the metaphysis, leading to a reduction of anti-rotation resistance for the stem while a supracondylar osteotomy increases the wound surface and makes a second surgery necessary.[5)]

On the other hand, a subtrochanteric osteotomy permits simultaneous shortening and correction of femoral anteversion, serving as a fulcrum for prevention of rotation at the proximal osteotomy site and at the same time preserving the metaphysis. Transverse, oblique, step-cut, and chevron are the various geometrical types of subtrochanteric osteotomy, out of which step-cut and chevron types provide better rotational stability at the osteotomy site.[6)] A proximal modular femoral stem such as S-ROM or Restoration is used in patients with high hip dislocations in order to achieve optimum femoral anteversion. This study was performed to investigate the role of the subtrochanteric step-cut shortening osteotomy in restoring the correct hip center and biomechanics, which in turn affects the functional and clinical outcome in terms of range of motion (ROM) of the hip joint, union at the osteotomy site, and timing of weight-bearing.

METHODS

Institutional ethical clearance (IRB No. IEC/VMMC/SJH/2015/223) was obtained. Written informed consent was obtained from all the patients authorizing treatment and radiological and photographic data documentation.

A prospective study was conducted in our tertiary care center from July 1, 2015, to December 31, 2019. A total of 24 patients who visited the outpatient department with a complaint of severe pain in the hip, shortening of the affected limb, and difficulty in walking and performing activities of daily living and were clinico-radiologically diagnosed with neglected traumatic dislocations of hip were included in the study. Patients with less than 18 years of age, bilateral hip involvement, previous history of surgery at the hip, paralytic hip dislocation, and pathological fracture were excluded from our study (Fig. 1).

A complete history was taken and physical examination was performed. Neurovascular status was assessed

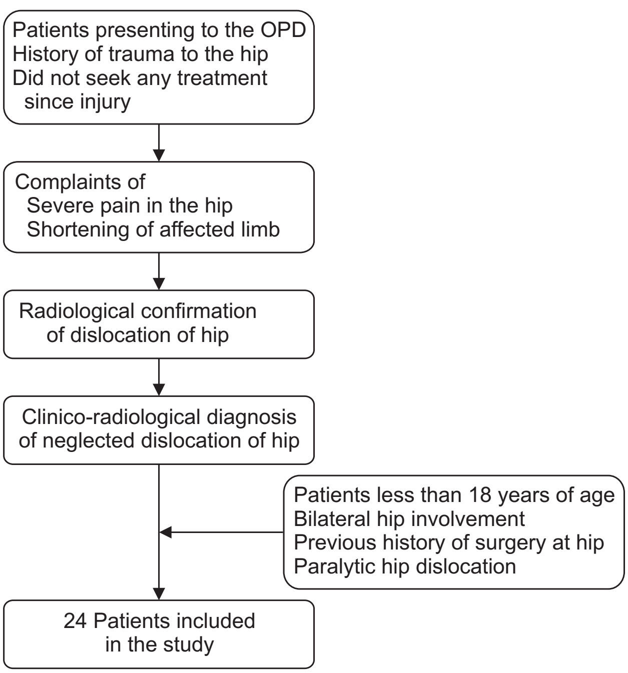

Fig. 1. Methodology of patient selection in the outpatient department (OPD).

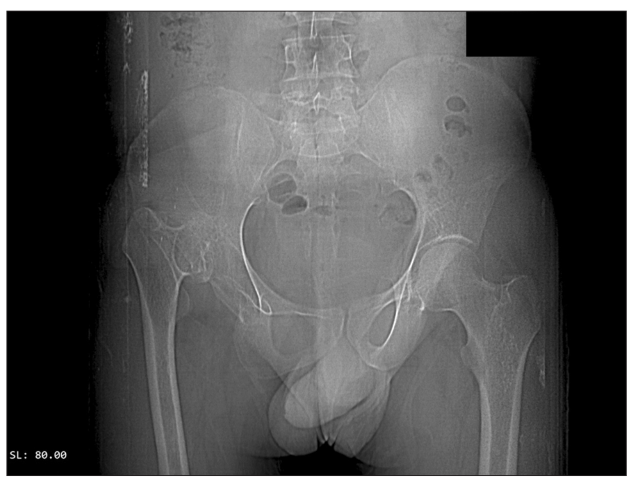

Fig. 2. Preoperative radiograph showing dislocation of the right femoral head with proximal migration in patient 1.

Fig. 3. Preoperative radiograph showing dislocation of the right femoral head with proximal migration in patient 2.

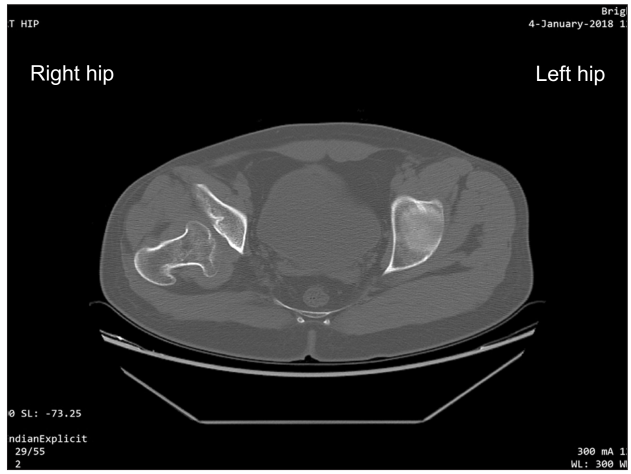

Fig. 4. Preoperative computed tomography scan transverse cut at the level of the superior lip of the acetabulum. The affected side (right) shows the hip dislocated and proximally migrated.

in all patients undergoing the procedure. Standard anteroposterior and lateral radiographs of the pelvis and hip, lumbosacral spine, and lower limbs were obtained (Figs. 2 and 3). Three-dimensional computed tomography scan (Figs. 4 and 5) was done in all patients to evaluate the acetabular side geometry with a special focus on the anterior and posterior columns or any bone loss. Templating of the hip was routinely done to assess the size of components, the anatomic hip center, and the amount of shortening and to mark the presumptive site of osteotomy. Preoperative evaluation was performed using the Harris Hip Score (HHS) and abductor function was assessed using the Trendelenburg test if possible. Preoperative routine blood investigations were performed. Combined spinal epidural anesthesia was given in all the patients. All the patients were operated in the lateral decubitus position. The affected limb was scrubbed, painted, and draped as per standard methods. Intravenous antibiotics were administered 30 minutes before starting the procedure. Tranexamic acid 1 g was given in all patients 15 minutes before the start of the procedure and 1 gm at the time of closure. All patients underwent primary total hip arthroplasty (THA) with the subtrochanteric step-cut shortening osteotomy.

Surgical Technique

All the patients were operated with a standard posterolateral approach for the hip joint in the lateral decubitus position. Before final positioning, all the patients were assessed for contracture of the adductors. If found to be contracted, a percutaneous adductor tenotomy was performed. After exposure of the proximal femur and greater trochanteric region, the sciatic nerve was carefully palpated and its relation in respect to the greater trochanter was assessed. After dissection of the short external rotators, the hip joint was exposed and the femoral head was dislocated posteriorly.

Following posterior reflection of these structures, the acetabulum was identified. It is of utmost importance to identify the true acetabulum by the presence of the transverse acetabular ligament and the pulvinar fat. This was done to avoid dissection and accidental implantation of the cup in pseudoacetabulum, which would proximally migrate the center of the hip joint. An approximate center of the femoral head in relation to the true acetabulum was marked to estimate proximal overriding of the femur. Gentle longitudinal traction was provided to the limb to evaluate the possible correction of shortening.

As a rough guide, if the center of the head lies much proximal to the superior acetabular margin, a shortening osteotomy of the femur would be required (Fig. 6). Next, the neck was cut with an L-shaped osteotomy at the level determined by preoperative templating. The acetabulum was then widened and deepened at a designated angle of abduction and anteversion. In all cases, acetabular fixation was cementless and the press-fit type and screws were inserted to increase cup stability. After implantation of the acetabular component, femoral side preparation was done with incremental rasps. Immediately before the femoral canal reached the final size of reaming, a trial reduction was attempted over the femoral rasp. In these cases, non-achievement of trial reduction was anticipated as mentioned above.

In an attempt to achieve reduction, a transverse osteotomy was made 1 cm below the lower border of the lesser trochanter. Before osteotomizing, the linea aspera was marked with a cautery or light saw blade to match the

Fig. 5. Preoperative three-dimensional computed tomography scans of patient 1. (A) Right hip oblique view. (B) Right hip lateral view.

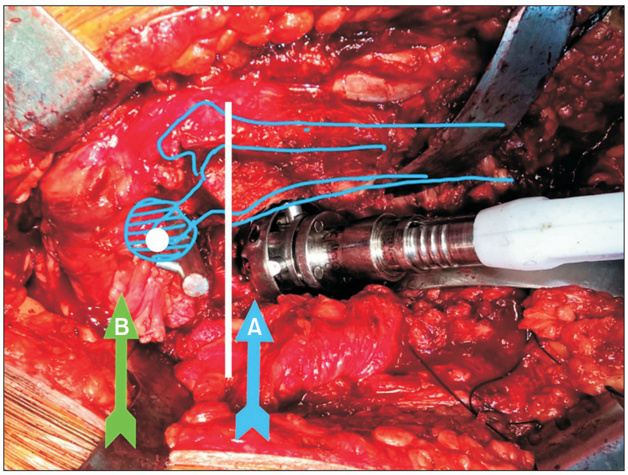

Fig. 6. Center of the head (white dot) lying much above the superior lip of the acetabulum (white line) and the presumptive center of the hip (arrow B). Distance between arrow A and B is a rough guide for shortening.

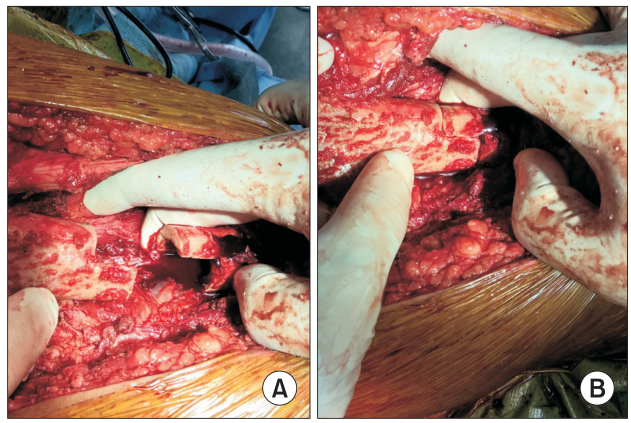

Fig. 7. (A) Calculated segment of bone removed and steps created. (B) Step-cut osteotomy reduced and opposed.

native femoral rotation in a later stage or to evaluate any correction of rotation if required. The rasp was then engaged in the proximal fragment and the hip joint was reduced. After reduction, an estimate of femoral shortening required was made by the overlapping proximal and distal femoral shaft. The equality of limb length with the opposite side was done by palpating the levels of distal femur on both sides as we routinely do during THA to evaluate the equality of intraoperative limb length.

A fragment of femoral shaft was then removed, its size being 2 cm less than the amount of overlap. This was done to accommodate a 1 cm step cut on either side of the osteotomy. After removal of femoral bone fragment, the transverse osteotomy was converted into a step cut with a 1 cm deep L-shaped step cut on either side (Fig. 7). The opposing surfaces of the step-cut osteotomy should be in the sagittal plane for better rotational stability. Any correction of rotation could be performed in this stage. The osteotomy was then reduced and femoral canal was then reamed with the long reamers. We used the Restoration Modular system (Stryker Corp., Kalamazoo, MI, USA) in all our cases. After reaching the correct size of reamer, trial reduction was carried out. The tension in the sciatic nerve was evaluated subjectively by finger palpation based on the surgeon's experience. Any rotation adjustment, which needs to be corrected on the femoral size, could be done with the modular system. The final implants were then implanted. The operation time and intraoperative blood loss were recorded. The wound was then closed in layers over suction drain.

Postoperative Protocol

The limb was kept in 10° abduction till first dressing on postoperative day 2. Drain removal was done 24 hours postoperatively. Intravenous antibiotics were given till postoperative day 2 and thereafter patients were shifted to oral antibiotics till another week as per our hospital policy. Deep vein thrombosis prophylaxis was given as a routine in all the patients. All patients were encouraged non-weight-bearing mobilization from postoperative day 2 onwards and encouraged to perform hip flexion and extension movements. Partial weight-bearing with the help of a walking frame was allowed after 1 week. Clinical and radiological follow-ups were done at 1, 3, 6, 12, and 24 months postoperatively and thereafter. The mean follow-up period was 21.2 ± 3.03 months (Figs. 8 and 9). ROM was assessed with a goniometer. Pain was assessed using a visual analog scale (VAS). Clinical outcome of the patients was assessed using the HHS. The HHS scoring system classified the evaluated items into major categories: in this scale, 50 points are assigned to function, 40 points to pain, and 10 points to alignment. Usually, a score between 90 and 100 is considered excellent, 75–89 good, 50–74 fair, and < 50 poor. No patients were lost to follow-up.

Statistical Analysis

Categorical variables are presented in number and percentage (%) and continuous and discrete variables are presented as mean ± standard deviation (SD) and median (range). Quantitative variables were compared using a paired *t*-test. A *p*-value of < 0.05 was considered statistically significant. Sample size was calculated according to the standard sample size formula, taking the mean HHS value after 2 years as the reference. The data were entered in MS Excel spreadsheet and analysis was done using IBM SPSS ver. 21.0 (IBM Corp., Armonk, NY, USA).

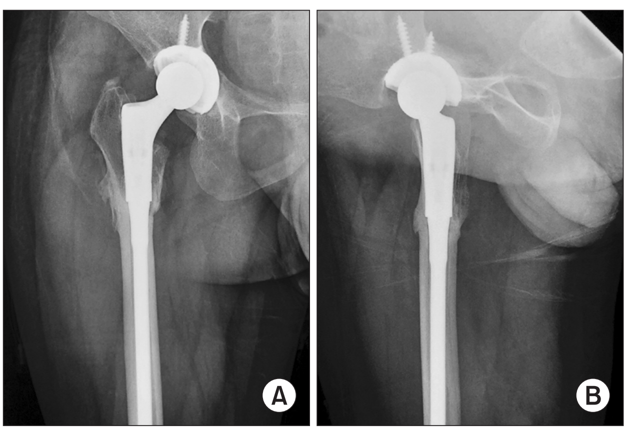

Fig. 8. Final Follow-up radiographs of patient 1. (A) Anteroposterior. (B) Lateral.

RESULTS

In the present study, a total of 24 patients with neglected traumatic hip dislocations were included and following observations were made. The age ranged from 28 years to 69 years. The mean age of the patients was 52 ± 8.85 years. There was male predominance with men to women ratio being 7 : 1. The mean length of bone removed was 43.4 ± 5.20 mm. The mean limb lengthening was 36 ± 6.25 mm. The average HHS improved from 33.4 ± 6.71 preoperatively to 89.2 ± 2.68 postoperatively at the latest follow-up evaluation ($p < 0.01$). There were no complaints of any postoperative pain and all the patients were able to perform daily routine activities and were able to walk upstairs and downstairs without any support. The mean preoperative VAS score was 8.71 ± 0.4 and the mean postoperative VAS score at 1 month was 3.9 ± 0.5. At 3 months, it was 2.4 ± 0.5, at 6 months, it was 1.3 ± 0.5, at 12 months, it was 0.5 ± 0.5 and it was the same thereafter. The *p*-value was found to be statistically significant (< 0.05).

The average blood loss was 2,260 mL (range, 1,200–4,200 mL). The average duration of surgery was 128 minutes (range, 102–198 minutes). The mean limb length discrepancy significantly decreased from 38 mm (range, 22–56 mm) preoperatively to 19 mm (range, 7–29 mm) at the final follow-up. The COR of hip was restored in all patients within 2 mm of that of the contralateral side, except in 1 patient with 6 mm proximal displacement of the native COR of the hip. All the patients were treated with a Restoration Modular femoral stem (Stryker Corp., Kalamazoo, MI, USA). A Trident PSL-HA cementless acetabular cup system (Stryker) was used in all patients except 1 patient in whom a cemented cup was used. The mean outer diameter of the acetabular component was 48 ± 3.17 mm. The mean diameter of the femur head was 32 mm (range, 28–36 mm). The average distal diameter of the stem was

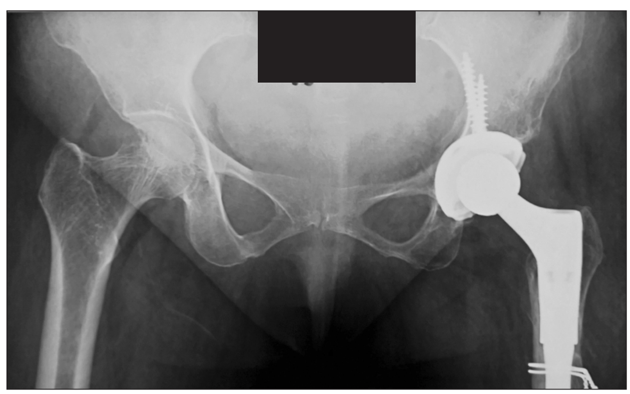

Fig. 9. Final follow-up anteroposterior radiograph of patient 2.

Table 1. The Study Master-Chart Including Preoperative and Postoperative HHS

No.	Sex	Age (yr)	Side	Length of bone removed (mm)	Outer diameter of cup (mm)	Union time (mo)	Follow-up (mo)	Preperative HHS	Postoperative HHS
1	Male	54	Right	43.3	48	4.1	21.4	36.8	92.4
2	Male	45	Right	44.4	42	3.4	22.6	31.9	89.2
3	Male	58	Left	45.5	48	4.2	19.1	26.8	88.2
4	Male	37	Right	39.6	52	3.8	24.1	43.9	87.8
5	Male	52	Left	32.8	52	3.6	19.7	29.8	88.4
6	Male	56	Right	49.6	48	4.2	20.1	37.2	93.6
7	Male	42	Right	53.8	52	3.2	32.0	22.8	87.1
8	Male	60	Right	47.2	44	5.4	18.6	35.5	90.4
9	Male	52	Left	48.2	54	5.2	18.8	41.2	96.0
10	Male	50	Right	45.7	48	4.2	19.0	31.8	86.7
11	Female	60	Right	39.4	48	6.6	18.0	48.0	88.2
12	Male	54	Right	43.8	44	3.7	20.1	24.4	86.1
13	Female	54	Left	51.2	46	4.4	20.8	22.6	85.0
14	Male	39	Right	37.1	50	3.6	19.8	34.7	87.6
15	Male	28	Left	36	44	4.2	19.5	36.8	91.3
16	Male	55	Right	44	52	7.8	21.6	21.0	89.8
17	Male	53	Right	42.5	48	5.1	19	38.1	90.9
18	Male	60	Right	51.1	46	6.4	26.2	34.4	86.2
19	Male	54	Right	38.8	48	3.2	21.0	33.5	89.1
20	Male	60	Left	37.1	52	4.9	22.2	36.6	92.0
21	Male	69	Right	42.8	44	8.3	19.7	32.8	88.4
22	Male	50	Right	43.2	48	3.4	18.0	28.8	86.1
23	Female	58	Right	44.3	48	4.2	20.2	33.6	89.6
24	Male	48	Right	40.6	46	3.9	21.6	38.8	92.2

HHS: Harris Hip Score.

10 mm (range, 8–13 mm).

No nonunion was seen at the osteotomy site at the latest follow-up. The mean period for osteotomy union was 4.6 ± 1.38 months. There were no neurologic complications. No infection or loosening of the prosthesis was observed and no early or late wound dehiscence due to infection occurred (Table 1).

DISCUSSION

Step-cut and double chevron osteotomies have been advocated by some authors, but both techniques are complicated and are time-consuming procedures. With the subtrochanteric step-cut osteotomy, there are less chances of hip dislocation, and sciatic nerve palsy and excessive femoral anteversion can also be addressed.[5] Hypoplastic true acetabulum, excessive femoral anteversion, narrow medullary canal, proximal migration of femoral head, and defective abductor mechanism alter the anatomy and biomechanics of the hip.[7] With the help of the modular femoral prosthesis, the need for adjusting excessive anteversion of a distorted proximal femur by the osteotomy technique itself can been excluded. The proximal shortening osteotomy with distal advancement of the greater trochanter was the generally used technique to increase the moment arm of the abductors.[8)] The subtrochanteric step-cut shortening osteotomy maintains greater trochanter and abductors at anatomical position.[9)] In a study of 21 cases, Li et al.[5)] concluded that in primary THA for the treatment of irreducible developmental dyslasia of the hip, the subtrochanteric oblique osteotomy combined with the freely rotatable S-ROM stem provided favorable short-term outcomes by providing both morphological and functional advantages. Nonunion at the osteotomy site is one of the major complications associated with the subtrochanteric shortening osteotomy. Instability of the osteotomy site results in complications, such as a delayed union and nonunion, which have been reported to occur in 0% to 13%.[10)] Masonis et al.[11)] performed 21 primary THAs in patients with Crowe grade 3 or 4 hip dysplasia using a subtrochanteric shortening osteotomy with an average follow-up of 5.8 years and observed that 91% of osteotomies healed without complication, 2 osteotomy nonunions required revision, 2 acetabular revisions were performed for malposition and polyethylene failure, and 3 patients experienced postoperative dislocation. One cemented femoral component was revised for loosening. In the current study, there were no cases of delayed union, nonunion, infection, or loosening.

Difference in canal diameter of the proximal femoral segment and distal femoral segment can increase the risk of nonunion. To address this, the long modular Restoration stem was used since it provides rotational stability and compression pressure at the osteotomy site.[5)] This can be achieved by matching different-sized proximal body with the distal fluted or conical stems in the Restoration modular system. Rollo et al.[12)] retrospectively reviewed 15 patients with Crowe type IV hip dysplasia treated with cementless total hip replacement associated with shortening subtrochanteric osteotomies and they healed at an average of 12.3 weeks. The mean HHS improved from 38.3 (range, 32–52) to 85.6 (range, 69–90). Howie et al.[13)] retrospectively reviewed 28 patients (35 hips) and noted union in 97% of the patients. The mean 12-Item Short Form Health Survey (SF-12) physical component score increased from 32 to 52 and the mean SF-12 mental component score increased from 48 to 51. The mean Oxford Hip Score decreased from 40 to 27. In our study, the average HHS improved from 33.4 ± 6.71 preoperatively to 89.2 ± 2.68 postoperatively, which is similar to other studies. In a study conducted by Neumann et al.,[14)] at 60 months of follow-up, 10 cases had good to excellent outcome scores. In a study conducted by Dastane et al.,[15)] it was concluded that the correct COR of hip was an important factor to restore the hip offsets and biomechanics. We were able to restore the COR of hip to within 2 mm of the native COR in all but 1 case. The limitation of our study includes the relatively short follow-up used to determine the outcomes and the small number of patients enrolled. Hence, large-scale, long-term follow-up studies are needed to confirm these benefits.

THA combined with a step-cut subtrochanteric femoral shortening osteotomy in patients with neglected traumatic dislocations of the hip was associated with good functional outcome and a higher success rate in terms of stable implant fixation and union at the osteotomy site. Therefore, we recommend use of an uncemented acetabular cup and a long modular stem with a step-cut subtrochanteric shortening osteotomy for neglected traumatic dislocations of the hip.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ORCID

Jatin Talwar https://orcid.org/0000-0002-4668-0414
Saumya Agarwal https://orcid.org/0000-0002-5429-8717
Sarang Agarwal https://orcid.org/0000-0002-3984-1515
Loveneesh G. Krishna https://orcid.org/0000-0001-9724-7787
Ashish Rustagi https://orcid.org/0000-0003-1134-3378

REFERENCES

1. Hougaard K, Thomsen PB. Traumatic posterior fracture-dislocation of the hip with fracture of the femoral head or neck, or both. J Bone Joint Surg Am. 1988;70(2):233-9.

2. Rasi AM, Kazemian G, Khak M, Zarei R. Shortening subtrochanteric osteotomy and cup placement at true acetabulum in total hip arthroplasty of Crowe III-IV developmental dysplasia: results of midterm follow-up. Eur J Orthop Surg Traumatol. 2018;28(5):923-30.

3. Bicanic G, Barbaric K, Bohacek I, Aljinovic A, Delimar D. Current concept in dysplastic hip arthroplasty: techniques

for acetabular and femoral reconstruction. World J Orthop. 2014;5(4):412-24.

4. 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(9):2213-21.

5. Li L, Yu M, Yang C, Gu G. Total hip arthroplasty (S-ROM stem) and subtrochanteric osteotomy for Crowe type IV developmental dysplasia of the hip. Indian J Orthop. 2016; 50(2):195-200.

6. Sener N, Tozun IR, Asik M. Femoral shortening and cementless arthroplasty in high congenital dislocation of the hip. J Arthroplasty. 2002;17(1):41-8.

7. Jacobsen S, Sonne-Holm S. Hip dysplasia: a significant risk factor for the development of hip osteoarthritis: a cross-sectional survey. Rheumatology (Oxford). 2005;44(2):211-8.

8. Eskelinen A, Remes V, Ylinen P, Helenius I, Tallroth K, Paavilainen T. Cementless total hip arthroplasty in patients with severely dysplastic hips and a previous Schanz osteotomy of the femur: techniques, pitfalls, and long-term outcome. Acta Orthop. 2009;80(3):263-9.

9. Ozden VE, Dikmen G, Beksac B, Tozun IR. Total hip arthroplasty with step-cut subtrochanteric femoral shortening osteotomy in high riding hip dislocated patients with previous femoral osteotomy. J Orthop Sci. 2017;22(3):517-23.

10. 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(1):117-25.

11. Masonis JL, Patel JV, Miu A, et al. Subtrochanteric shortening and derotational osteotomy in primary total hip arthroplasty for patients with severe hip dysplasia: 5-year follow-up. J Arthroplasty. 2003;18(3 Suppl 1):68-73.

12. Rollo G, Solarino G, Vicenti G, Picca G, Carrozzo M, Moretti B. Subtrochanteric femoral shortening osteotomy combined with cementless total hip replacement for Crowe type IV developmental dysplasia: a retrospective study. J Orthop Traumatol. 2017;18(4):407-13.

13. Howie CR, Ohly NE, Miller B. Cemented total hip arthroplasty with subtrochanteric osteotomy in dysplastic hips. Clin Orthop Relat Res. 2010;468(12):3240-7.

14. Neumann D, Thaler C, Dorn U. Femoral shortening and cementless arthroplasty in Crowe type 4 congenital dislocation of the hip. Int Orthop. 2012;36(3):499-503.

15. Dastane M, Dorr LD, Tarwala R, Wan Z. Hip offset in total hip arthroplasty: quantitative measurement with navigation. Clin Orthop Relat Res. 2011;469(2):429-36.