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Technique and outcomes of Total Hip Arthroplasty with or without sub-trochanteric shortening osteotomy for neglected post-traumatic hip fracture-dislocations: A case-series

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1. Introduction

Posterior fracture-dislocations of the hip are high velocity injuries and require urgent reduction.[1] Failed Open Reduction and Internal Fixation (ORIF) is not unusual following these injuries. Neglected persistent post-traumatic posterior dislocation of the hip with or without an acetabular fracture is a rare presentation in the developed world, but not unusual in developing countries.[2] Total Hip Arthroplasty (THA) is the treatment of choice for complicated or neglected posterior fracture-dislocations of the hip and failed surgery, but is rendered more complex in neglected persistently dislocated hips.[2–5]

Surgical challenges include the presence of a superiorly and posteriorly migrated proximal femur, soft tissue contractures warranting extensive release to restore the hip to its native center of rotation, and varying degrees of segmental acetabular bony defects that might require additional acetabular reconstruction procedures.[3] Identification of the true acetabulum can be difficult. As the duration of the dislocation increases, so does the soft tissue contracture, shortening of the limb and the risk of sciatic nerve injury following reduction of the hip. These patients are also at risk of developing Heterotopic Ossification (HO), and may require prophylactic medication.[6]

This study describes our experience with twelve patients with neglected persistent posterior dislocations of the hip with acetabular fractures, who presented to us 2–22 years following the index trauma. They were treated with THA with or without Sub-Trochanteric Shortening Osteotomy (STSO) on the femoral side, and with or without acetabular reconstruction. To the best of our knowledge, this is the first study to report the role of STSO in conjunction with THA in a post-traumatic setting, for chronic neglected hip fracture-dislocations.

2. Materials and methods

Following approval from the Institutional Ethics Committee, a descriptive study was undertaken with the objective of reviewing clinical and radiological outcomes of patients following THA for neglected traumatic posterior hip dislocations with acetabular fractures. All patients with a traumatic etiology, with a persistent dislocation for at least 3 months following the index trauma at the time of presentation were included for the purposes of this study. Informed consent was obtained from all patients prior to data collection. Prospectively obtained data from a password-protected computerized database was collected.

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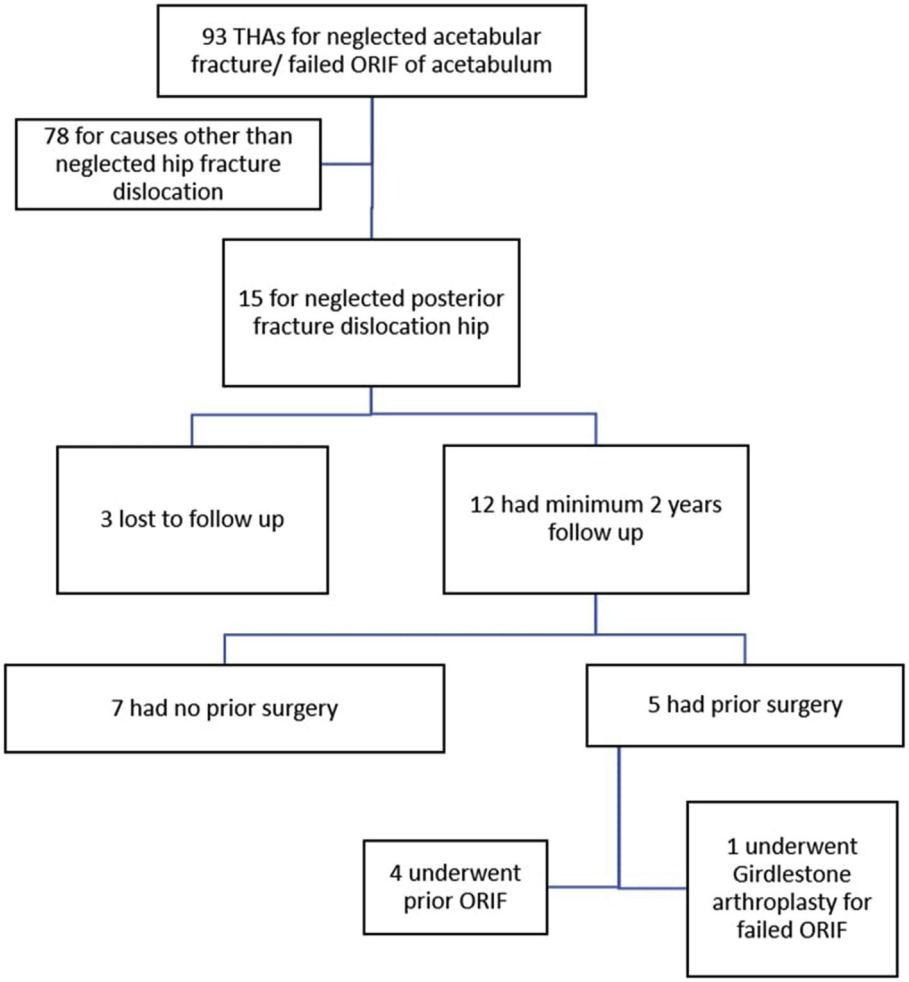

Fig. 1. Flowchart showing recruitment of patients for the study.

Between June 2006 and June 2018, we performed 93 THAs for patients with neglected acetabular fractures or failed Open Reduction and Internal Fixation (ORIF) of the acetabulum (Fig. 1). Among this group, 15 patients (16%) underwent THA for neglected post-traumatic persistent posterior dislocations of the hip (≥3 months since the time of the index trauma) with or without acetabular fracture. Three patients were lost to follow-up, leaving 12 patients with a minimum follow-up of 2 years. Five patients among this cohort underwent prior ORIF which failed, resulting in persistent hip dislocation. One of these five patients had undergone Girdlestone arthroplasty for persistent dislocation of the hip following a failed acetabular ORIF.

Demographic, clinical and radiological data was documented. All patients were evaluated clinically and radiologically prior to THA. ESR and CRP were obtained to rule out infection in patients with a history of previous surgery. All fractures were classified using the Stewart and Milford classification[7] (Table 1). Clinical evaluation was performed using the modified Merle d'Aubigne system[8] and radiological assessment was based on DeLee and Charnley criteria.[9] Wilcoxon signed rank test was used to compare pre and post-operative clinical outcomes. SPSS software (version 13.0) was used for statistical analysis.

Table 1
Stewart and Milford classification of hip dislocations, along with number of cases in each type.

Type	Description	Number of cases
1	No acetabular fracture (or) only a minor chip	0
2	Posterior rim fracture that is stable after reduction	3
3	Posterior rim fracture with hip instability after reduction	9
4	Dislocation accompanied by fracture of the femoral head or neck	0

2.1. Surgical technique

All patients underwent a posterolateral approach in the lateral decubitus position. Soft tissue releases were performed sequentially to obtain complete surgical exposure. The first step was to release the gluteus maximus tendon from its femoral insertion. The short external rotators and posterior capsule were then released in a single layer along the posterior border of the greater trochanter-between the interval of the posterior borders of the gluteus medius and the vastus lateralis. This approach avoided inadvertent injury to the sciatic nerve as the nerve was not routinely identified and explored. Vertical and horizontal offset of the residual femoral head were measured and a neck cut was performed accordingly. The head was reserved for possible use as an autograft.

The proximal femur was circumferentially released starting 3 cm below the lesser trochanter. A 300° release of the psoas and anterior capsule was performed, leaving the abductors attached to

the greater trochanter. This allowed for adequate internal rotation and anterior translation of the femur to achieve acetabular exposure. The abductor muscles were now released from the ilium taking care to avoid injuring the superior gluteal neurovascular pedicle. The reflected head of the rectus femoris was released from the acetabular margin in all cases. The acetabulum was debrided of all fibrous tissue by dissecting within the confines of its anterior and posterior walls to avoid neurovascular injury.

Three patients (25%) did not require acetabular augmentation and were managed with primary hemispherical cementless acetabular shells (Fig. 2). Nine patients (75%) had 30–50% segmental deficiency of the acetabulum which required augmentation. Eight of the nine patients (89%) were managed using the native femoral head as an autograft. The autograft was provisionally fixed with three k-wires in the periphery of the graft. Sequential acetabular reaming was carried out to achieve 2-point contact in the residual host bone between the anterosuperior and posteroinferior columns. The acetabular implant was then fixed with 2–3 supplemental screws. The graft was definitively fixed using three 4 mm cannulated cancellous screws. In two patients with a segmental defect greater than 40%, an additional buttress plate was used over the graft. The patient with a prior Girdlestone arthroplasty with an acetabular defect was managed using a cemented cup and impaction bone grafting.

Femoral preparation was performed next, followed by an attempt at trial reduction. In four patients (33%), hip reduction was not possible despite extensive soft tissue release. Three of these had undergone no prior surgery, while one patient was post Girdlestone arthroplasty. In these patients, STSO was performed 2 cm below the lesser trochanter. The trial implant was passed through the proximal fragment and the hip was reduced. Lower extremity traction was applied and the extent of bony overlap was measured. A corresponding segment of bone was removed from the distal fragment. The trial implant was introduced across the osteotomy site, into the distal fragment. The hip was then reduced and assessed for stability. Trial implants were replaced by the final implants. Interference fit of the final implants secured the osteotomy site. Bearing options used were as follows: Ceramic-on-polyethylene in 3 patients, ceramic-on-ceramic in 4 patients and metal-on-polyethylene in 5 patients. Implant details are summarized in Table 2.

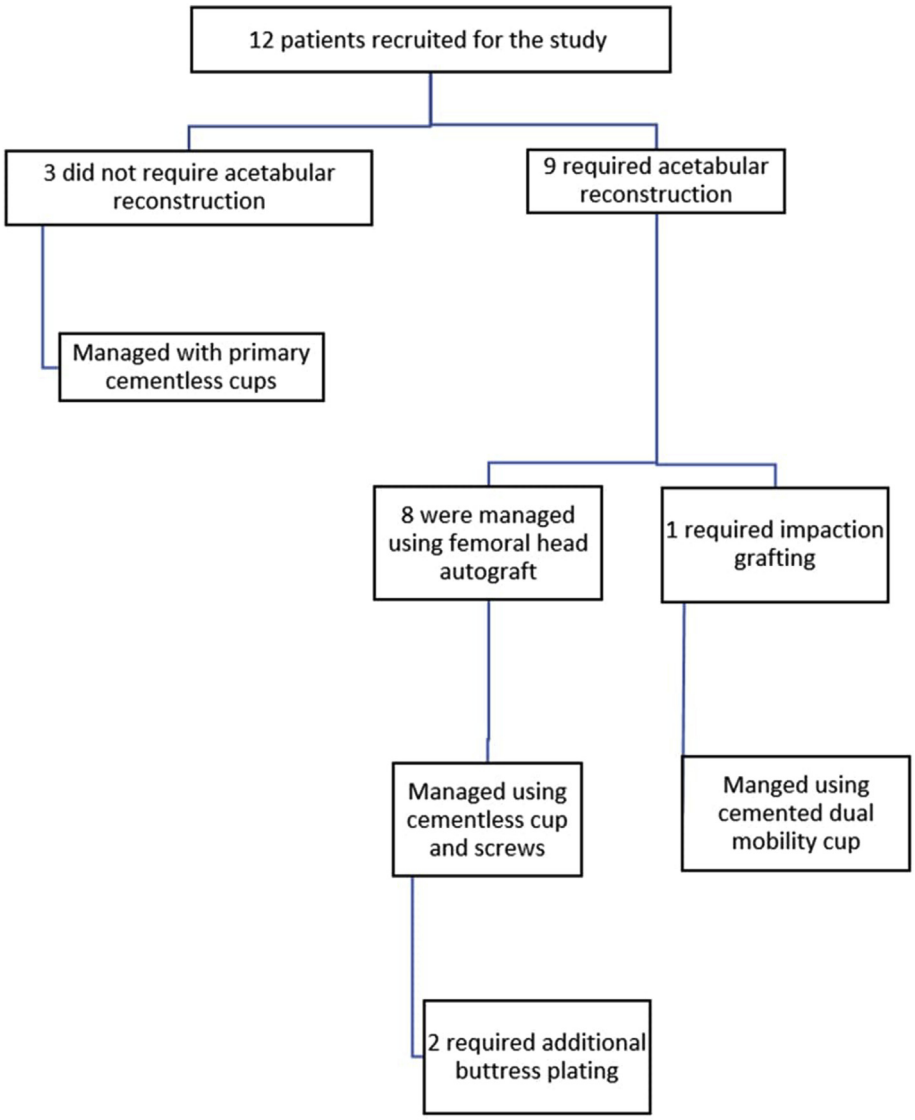

Fig. 2. Flowchart showing management of the recruited 12 patients in the study.

Table 2
Various implants used in the 12 patients.

Acetabular component	Number	Femoral component	Number
Pinnacle (DePuySynthes) (Cementless)	6	Corail (DePuySynthes) (Cementless)	3
Plasma Cup (BBraunAesculap) (Cementless)	3	Bicontact Regular (BBraunAesculap) (Cementless)	3
Continuum Cup (Zimmer) (Cementless)	1	Bicontact Revision (BBraunAesculap) (Cementless)	1
Trident Cup (Stryker) (Cementless)	1	ML Taper (Zimmer) (Cementless)	1
Exeter Cup (Stryker) (Cemented)	1	S-ROM (DePuySynthes) (Cementless)	1
		Solution (DePuySynthes)	1
		Exeter (Stryker) (Cemented)	1
		Accolade (Stryker) (Cementless)	1

2.2. Post-operative care and follow UP

All patients received three doses of Cefazoline post-operatively. Celecoxib 200 mg twice daily for four weeks was advised for HO prophylaxis.[10] Aspirin 75 mg twice daily for six weeks was used as Deep Venous Thrombosis (DVT) prophylaxis.[11,12] All patients treated with an autograft of the acetabulum in conjunction with STSO were ambulated non-weight-bearing for six weeks and advanced to partial-weight-bearing for an additional six weeks. All other patients were allowed to ambulate with a walker with weight-bearing as tolerated for the first six weeks post-operatively.

All patients were evaluated radiographically at 6 weeks, 3 months and 6 months post-operatively, and annually thereafter. All radiographs were evaluated by the senior author to assess acetabular inclination and version, and identify the presence of radiolucent lines, gaps and osteolysis as per DeLee and Charnley criteria.[9] The cup was deemed loose if there was a change in cup inclination of more than 10°, radiolucency of more than 1 mm in all zones and a change in the hip center of more than 6 mm.[13] Clinical evaluation was based on Matta's modification of Merle d'Aubigne scoring system.[8] (Table 3). All patients were contacted via telephone between March and June 2020 to confirm that their pain and ambulatory status had not deteriorated from the time of the last clinical follow-up.

Table 3
Matta's modification of Merle d'Aubigne hip scoring system.

Criteria	Points
Pain	
None	6
Slight or intermittent	5
After walking but resolves	4
Moderately severe but patient is able to walk	3
Severe, prevents walking	2
Walking	
Normal	6
No cane but slight limb	5
Long distance with cane or crutch	4
Limited even with support	3
Very limited	2
Unable to walk	1
Range of motion	
95–100%	6
80–94%	5
70–79%	4
60–69%	3
50–59%	2
Less than 50%	1
Clinical grading	
Excellent	18
Good	15–17
Fair	13–14
Poor	<13

3. Results

The mean patient age was 34.9 years (range: 21–54), with 10 male and 2 female patients. The mean duration of time following index trauma until presentation was 5.25 years (range: 2–22 years). The mean follow up was 6.3 years (range: 2–9 years). The mean pre-operative modified Merle d'Aubigne clinical score[8] was 4 (range: 3–5), and was poor in all the patients. All twelve patients had severe pain and four patients had no pre-operative range of motion. Seven patients were minimally ambulant, while five patients were unable to ambulate.

Associated injuries at the time of index trauma included fracture of the patella and tibia in one patient, ipsilateral femur fracture (managed by plate osteosynthesis) in one patient, contralateral femur fracture in one patient and a head injury in two patients. One patient had undergone Girdlestone arthroplasty for persistent hip dislocation following a failed acetabular ORIF.

The mean post-operative modified Merle d'Aubigne clinical score was 14.3 (range: 10–16) which was significantly higher than the mean pre-operative score ($p = 0.002$). The result was good in eight patients (67%), fair in three patients (25%) and poor in one patient (8%). All patients were ambulant following surgery. Three patients (25%) had partial sciatic nerve injury pre-operatively which persisted at the time of the last follow-up. Three patients (25%) sustained a posterior hip dislocation within 1 month of surgery. Two of these resolved by closed reduction and application of an extension knee brace for six weeks. One patient (who presented post Girdlestone arthroplasty) sustained three additional episodes of hip dislocation and underwent revision hip arthroplasty with a cemented dual-mobility socket and acetabular reconstruction using Trabecular Metal™ (TM) augment, one year following the primary THA.

All autografts were incorporated without radiographic signs of implant loosening. Four patients required STSO to restore the hip to its native centre of rotation. All patients with STSO went on to achieve union at a mean of 16 weeks (range: 12–20 weeks). The mean pre-operative shortening in patients who required STSO was 7 cm (range: 5 – 8 cm), which reduced to 2.7 cm (range: 2 – 4 cm) post-operatively. Among patients who did not require STSO, the mean pre-operative shortening was 3.5 cm (range: 2.5–5 cm),

which reduced to 0.5 cm (range: 0–2 cm) post-operatively. The overall mean pre-operative shortening was 4.4 cm (range 2.5–8 cm) which corrected to 1.2 cm (range 0–4 cm) following surgery. Six patients (4 with STSO and 2 without) had a post-operative limb length discrepancy of 1–4 cm, five of whom required height correction footwear. One patient with 4 cm shortening underwent a subsequent Ilizarov lengthening of the tibia. He had a dislocated stiff hip for 22 years and needed STSO with a Solution stem (DePuy Synthes). He had pre-operative knee stiffness which persisted following surgery. Though there was a joint level discrepancy between the limbs, his outcome was satisfactory otherwise. One patient had grade 2 HO following surgery, which did not affect his clinical outcome. Pre and post-operative radiographic and clinical images of a patient who required STSO are as shown in Figs. 3–5.

4. Discussion

Posterior fracture-dislocation of the hip is a high velocity injury and is best managed by early reduction of the hip and fixation of the posterior acetabular wall fragment if the hip is unstable after closed reduction. Despite early reduction, the complication rate after this clinical entity is high and includes avascular necrosis of the femoral head (50%) and post traumatic arthritis (30%).[2,7,14] There also exists a failure rate of 10% following ORIF.[15] There is minimal literature on salvage of neglected post-traumatic persistent posterior dislocations of the hip with or without acetabular fractures. Garett et al.[3] in 1979 recommended hip arthroplasty as a salvage option for the management of irreducible neglected hip fracture dislocations beyond 3 months, however in their series of 39 patients, only 2 patients were managed with THA, while 6 underwent cup arthroplasty and 1 had a bipolar hemiarthroplasty. Historically, staged THA[16] and cement filling of bone defects[17] has also been suggested for chronic posterior fracture-dislocations of the hip.

Ilyas et al.[18] evaluated 15 patients with chronic posterior fracture-dislocations of the hip, with a mean time to presentation of 7.6 months (range: 6–12 months), who underwent single stage THA (14 uncemented, 1 cage) and suggested that THA was effective in relieving pain and restoring function in these patients. Ten of their patients had previous failed surgery and five had been managed with skeletal traction alone but had persistent dislocation. All patients in this series had posterior acetabular wall segmental defects which were reconstructed using a femoral head autograft. At a mean follow-up of 71.5 months, all patients had stable implants with no evidence of graft resorption or implant loosening. The complication rate was 26.6%, with two dislocations, one transient peroneal nerve palsy and one superficial wound infection.

The results of our study are similar to those of Ilyas et al.,[18] though our patients presented from 2 to 22 years following the index trauma, which is a significantly longer time to presentation. This delay in presentation resulted in more complex reconstructions in our patients. Five patients among twelve had undergone prior ORIF, and presented with persistent dislocation due to failed surgery. The technique of reduction in these patients was similar to that described above, however more soft tissue scarring was noted. Among those who had not undergone prior surgery, more severe soft tissue contracture resulting in a high-riding hip was noted.

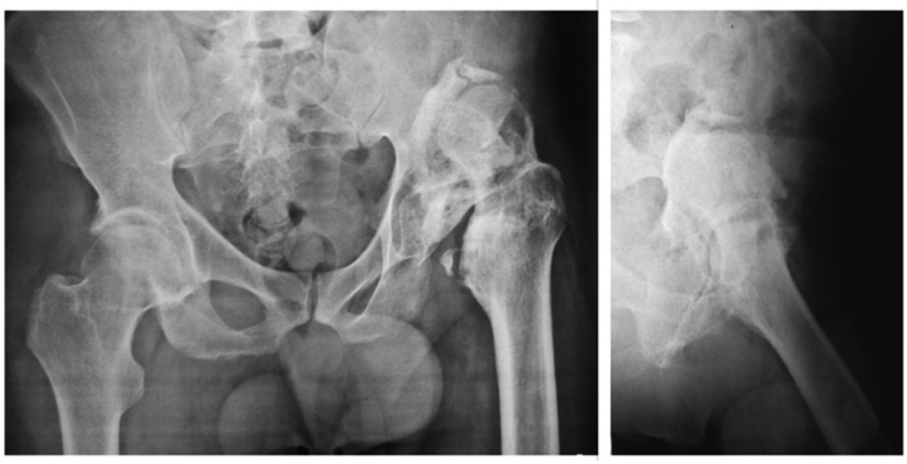

Fig. 3. Pre-operative radiographs of a patient with neglected hip fracture dislocation
C.1. Anteroposterior view pelvis
C.2. Judet view left hip showing neglected fracture dislocation left hip.

Fig. 4. Pre-operative CT 3d reconstruction.

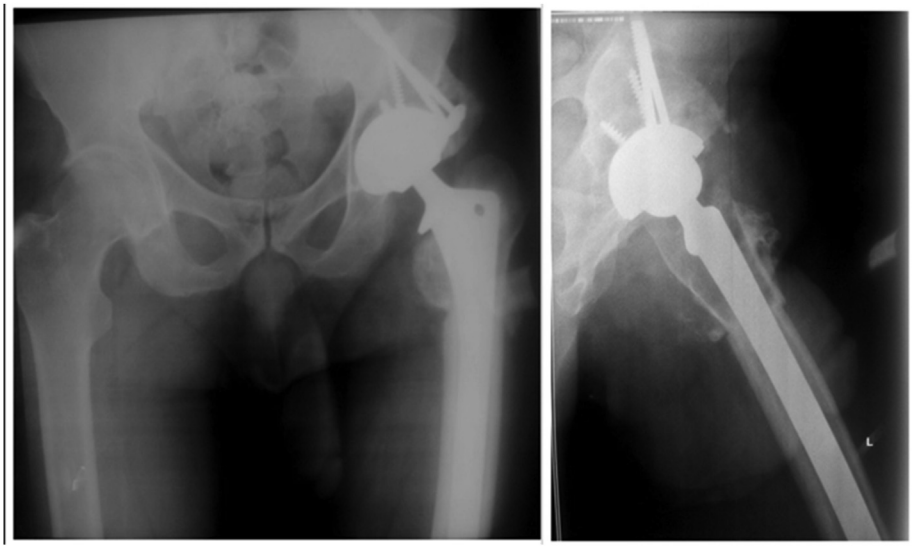

Fig. 5. Radiographs at 7 years follow-up after cementless THA with acetabular autograft and STSO fixed with Solution stem showing graft incorporation and healing of osteotomy
E.1. Anteroposterior view pelvis
E.2. Lateral view left hip.

Four patients in our series needed STSO to reduce the hip to its native center of rotation. These four patients had neglected dislocations with a duration ranging from 7 to 22 years from the time of the index trauma. Three among these had not undergone any prior surgery and the fourth patient presented following Girdlestone arthroplasty which he had undergone for a persistently dislocated hip due to failed acetabular ORIF. All four had severe soft tissue contracture, stiff hips and pre-operative shortening ranging from 5 to 8 cm. STSO is a well described procedure in the setting of THA for Crowe 4 dysplasia.[19–24] In this setting, the osteotomy helps in achieving reduction of the hip to its anatomic center of rotation after acetabular reconstruction, and protects the sciatic nerve. A 5–11.3% incidence of sciatic nerve injury following THA for patients with Crowe 4 dysplasia has been reported, which increases to 14.3% when lengthening of greater than 4 cm is performed.[25] None of the patients in the present series developed sciatic nerve injury following THA reconstruction.

Nonunion (2.8%–7.1%) is a potential complication of STSO.[26] One previous study reported open reduction and STSO in an adolescent with a 6-week old posterior fracture-dislocation of the hip.[27] To the best of our knowledge however, no prior publications have reported the use of single stage STSO and THA for neglected post-traumatic chronic posterior dislocations of the hip. Although we used different implant combinations in each of these cases, all patients achieved union. Another complication of STSO is residual limb length discrepancy. One patient in our series had 4 cm residual shortening and underwent Ilizarov leg lengthening one year post-operatively for a plantigrade foot. Four other patients who had a limb length discrepancy were able to perform their activities of daily living using height correction footwear.

A femoral head autograft was used to reconstruct the segmental posterior wall defect in eight patients. One potential benefit of using an autograft is the restoration of bone stock to facilitate future revisions. However, we believe that a potential problem of securing the autograft definitively prior to implantation of a cementless cup is the tendency to undersize the cup. Therefore, it is critical to fix the graft provisionally with k-wires, ream the residual acetabulum, achieve two-point contact between the remaining antero-superior and postero-inferior columns and size the cup correctly to achieve stable in-growth. With this method, even if the graft resorbs in the mid-term, satisfactory outcomes can still be achieved due to biologic fixation of the cementless shell to the residual host bone. No failures related to graft resorption or aseptic loosening were seen in the present series. This is similar to previously reported data in this sub-population, while using a femoral head autograft.[28]

An alternative to femoral head autograft reconstruction in segmental defects of the posterior wall is the use of TM augments. TM has a porosity and modulus of elasticity similar to that of cancellous bone and has demonstrated excellent in-growth potential.[29] The use of TM augments for managing segmental acetabular bone loss in revision surgery is well established.[30] This is sometimes necessitated when the quality of the native head is poor, if the head is resorbed or when a previous Girdlestone procedure has been performed. We used a TM augment to successfully reconstruct the segmental acetabular defect at the time of revision in the patient with prior Girdlestone arthroplasty.

Instability is a potential complication in these patients. We observed three dislocations post THA, two of which were managed by closed reduction, while one required revision surgery. The presence of severe pre-operative contractures and a chronic high-riding hip necessitate a circumferential proximal femoral release including the iliopsoas and anterior hip capsule. This can contribute to instability in the immediate post-operative period.

The presence of segmental acetabular defects and absence of anatomic landmarks render acetabular component positioning more difficult. There may be a tendency to underestimate the extent of bone defect. This may predispose to component retroversion. Intra-operative trial reduction and assessment of combined anteversion may help avoid this problem. Ilyas et al.[18] suggested that post-operative confinement to bed for 2–3 weeks and the use of hip bracing may be effective in reducing this complication. We believe this is impractical. We use a knee immobilizer for the first 3 weeks in these patients which reduces the ability to flex the hip, thereby reducing the risk of posterior dislocation.

What sets this study apart from existing reports in literature is the extremely long time to presentation (2–22 years) following index trauma, rendering THA in these cases complex and challenging. To our knowledge, the use of STSO in THA for neglected post-traumatic hip fracture-dislocations has not been reported before. Moreover, despite the challenges involved in surgery, all patients had significant clinical improvement and were ambulant

following surgery, while none had fresh onset sciatic nerve palsy. A limitation of this study is that it is retrospective, with a small number of patients. However, since chronic persistent posterior fracture-dislocations of the hip are uncommon, it would be difficult to conduct a prospective study with a large number of patients. Also, we had to use a wide variety of implants based on their availability and the financial resources of our patients, and hence could not standardize them.

5. Conclusion

THA with acetabular autografting can lead to pain relief, improved ambulation and successful mid-term results in patients with chronic persistent posterior dislocation of the hip with acetabular fractures. Instability is a potential problem and careful attention to intra-operative trial reduction and combined anteversion may help reduce this risk. We believe that the use of STSO is a helpful adjunct to THA in achieving reduction of the hip to its native center of rotation in these cases.

Ethics in publishing

Informed consent was obtained from all patients prior to data collection. Institutional Ethics Committee clearance was obtained prior to the study.

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CRediT authorship contribution statement

Krishna Kiran Eachempati: Conceptualization, Methodology, Validation, Investigation, Resources, Writing - original draft, Writing - review & editing, Visualization, Supervision, Project administration. **Apurve Parameswaran:** Methodology, Software, Formal analysis, Data curation, Writing - original draft, Writing - review & editing, Visualization. **Anil Kumar Reddy:** Conceptualization, Validation, Writing - review & editing. **Chandra Sekhar-Dannana:** Conceptualization, Validation, Project administration, Writing - review & editing. **Sunil Apsingi:** Conceptualization, Validation, Resources, Supervision, Project administration, Writing - review & editing. **Neil Sheth:** Conceptualization, Writing - review & editing.

Declaration of competing interest

None.

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