Surgical Dislocation or the Modified Heuter Anterior Approach for Pipkin I and II Femoral Head Fracture Dislocations

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Objectives: To compare outcomes after surgical treatment of Pipkin I and II femoral head fractures treated with either a surgical dislocation (SD) or a direct anterior approach (the modified Heuter approach).

Study Design: Retrospective, multicentre.

Setting: Three Level I trauma care centers.

Patients: Fourty-nine patients operated for Pipkin types I or II femoral head fractures. Twenty-seven using SD and 22 using the modified Heuter approach.

Interventions: Initial closed reduction of the joint followed by open reduction and internal fixation of the fracture/fragment excision. Fixation was performed using headless or countersunk mini fragment screws.

Outcome Measurements: The 2 groups were compared for (1) perioperative measures: blood loss, surgical time, pain [visual analog scale (VAS)], and length of hospital stay; (2) radiological outcome in terms of fracture union, occurrence of posttraumatic hip arthritis, and femoral head osteonecrosis; and (3) functional outcome using the modified Merle d' Aubigne score and Oxford hip scores.

Results: Surgical time, blood loss, and VAS at 24 hours were significantly lower in the modified Heuter group. The VAS at discharge and length of stay were similar in both groups. All fractures had united. No cases of osteonecrosis were observed. Functional outcome and complications were similar in both groups.

Conclusions: Both SD and the modified Heuter approach are effective in treating patients with Pipkin I and II femoral head fractures with comparable radiological and functional outcomes.

Accepted for publication May 20, 2020.
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The authors report no conflict of interest.
Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.jorthotrauma.com).
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DOI: 10.1097/BOT.0000000000001877

Key Words: Pipkin fractures, femoral head fractures, Ganz osteotomy, surgical dislocation, Heuter approach

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

(*J Orthop Trauma* 2020;34:626–631)

INTRODUCTION

Femoral head fractures are high-energy shear injuries often associated with a posterior hip dislocation.[1] According to Pipkin classification, types I and II are isolated head fractures differentiated by location while types III and IV have associated fractures in the femoral neck or acetabulum, respectively.[2] Type I and II injuries require prompt reduction of the hip joint. Well-reduced type I and II injuries can be treated nonoperatively. Definitive operative intervention is recommended in cases of irreducibility, persistent fracture displacement after joint reduction, or incongruent joint reduction created by articular loose fragments. Open reduction and internal fixation (ORIF) is recommended for displaced type I and II fractures while excision of small infrafoveolar fragments is an option for type I fractures where fixation is not possible.[3]

The choice of surgical approach to treat these injuries is less clear based on published results. Opting for a posterior approach is logical because the dislocation is often posterior resulting in a variable degree of posterior capsular tear, which can give access to the fracture without further capsular disruption. The fracture location, however, is often antero–inferior that makes it difficult to access and repair through the posterior approach. This often requires extension of the posterior capsular tear and recreating the initial injury to dislocate the hip posteriorly. The entire process can possibly jeopardize the femoral head capsular blood supply further. Thus concerns about interfering with the predominantly posterior-based blood supply to the femoral head have influenced surgeons to use anterior surgical approaches.[4] Currently, the modified Heuter anterior approach[5] that uses the distal extent of Smith-Peterson approach between the tensor fascia lata and the sartorius and the surgical dislocation (SD) popularized by Ganz[6] are the 2 most commonly performed approaches for treating femoral head fractures. Both approaches use an anterior-based capsulotomy to approach the fracture thereby avoiding further injury to the femoral head blood supply and provide direct access to the fracture site for reduction and fixation.

We had previously reported a prospective case series of femoral head fracture dislocations with good results using the SD.[7] In this retrospective review, we present a comparative analysis of ORIF/fragment excision for Pipkin I and II fractures performed either using the SD or the modified Heuter approach aiming to study possible advantages and disadvantages of one approach over the other.

MATERIALS AND METHODS

We performed a retrospective review of 53 patients with complete medical records who had underwent surgical management for Pipkin I and II fractures at our institution between February 2009 and July 2016. Thirty patients underwent ORIF/fragment excision using the flip osteotomy and safe SD, and 23 patients had undergone ORIF/fragment excision through the modified Heuter approach. Four patients could not be traced and so 49 patients were included in the final analysis. Our institutional review board approved the study, and informed consent was obtained from all patients to participate in the study.

Patients presenting with Pipkin fracture dislocations at the emergency department underwent closed reduction under conscious sedation/anesthesia at the earliest. Postreduction x-rays and computed tomography scans were performed to assess the congruency of the joint and adequacy of fracture

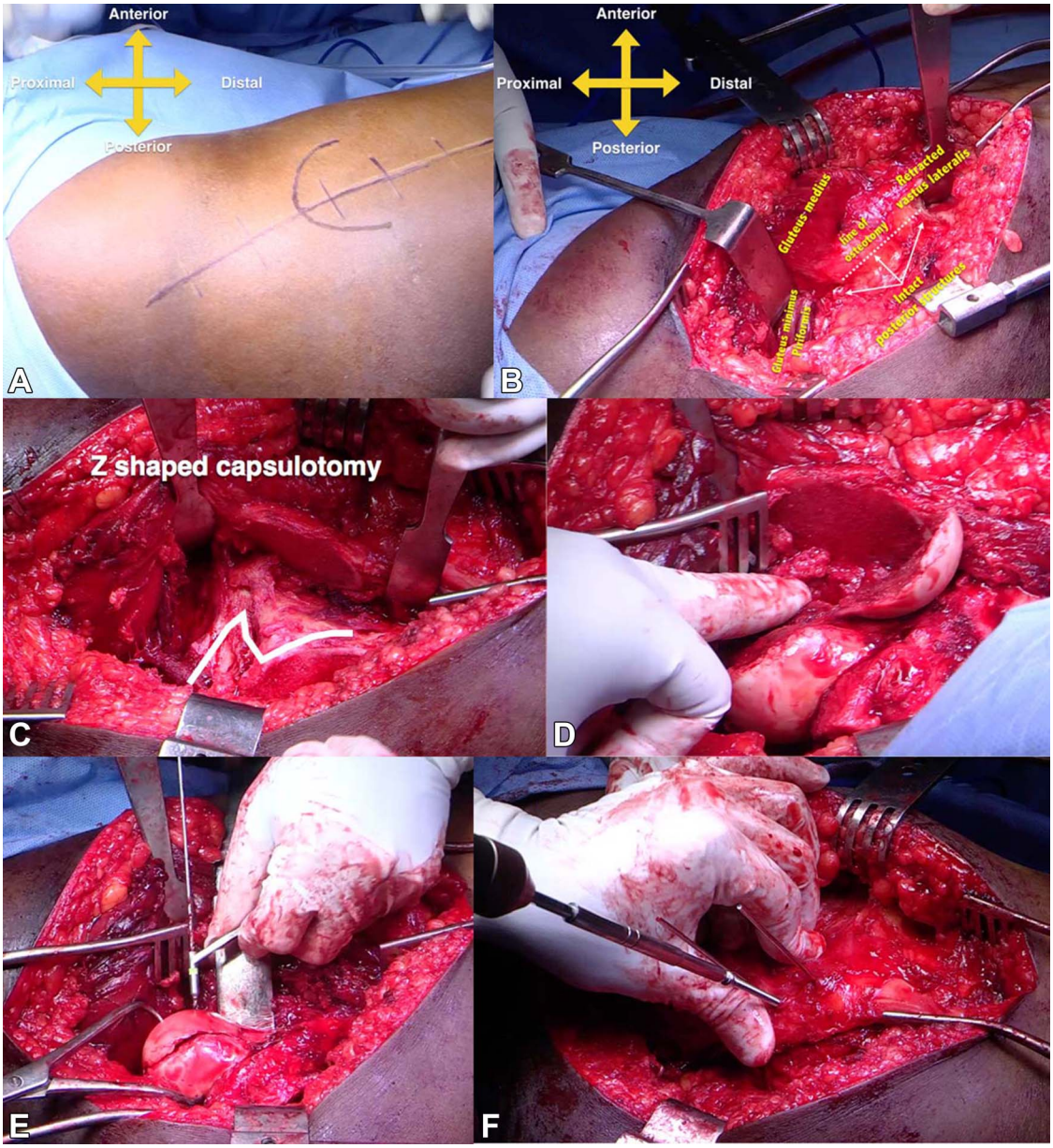

FIGURE 1. A–F, shows the steps of performing a safe surgical dislocation with a Ganz osteotomy for ORIF of a Pipkin type II femoral head fracture. **Editor's Note**: A color image accompanies the online version of this article.

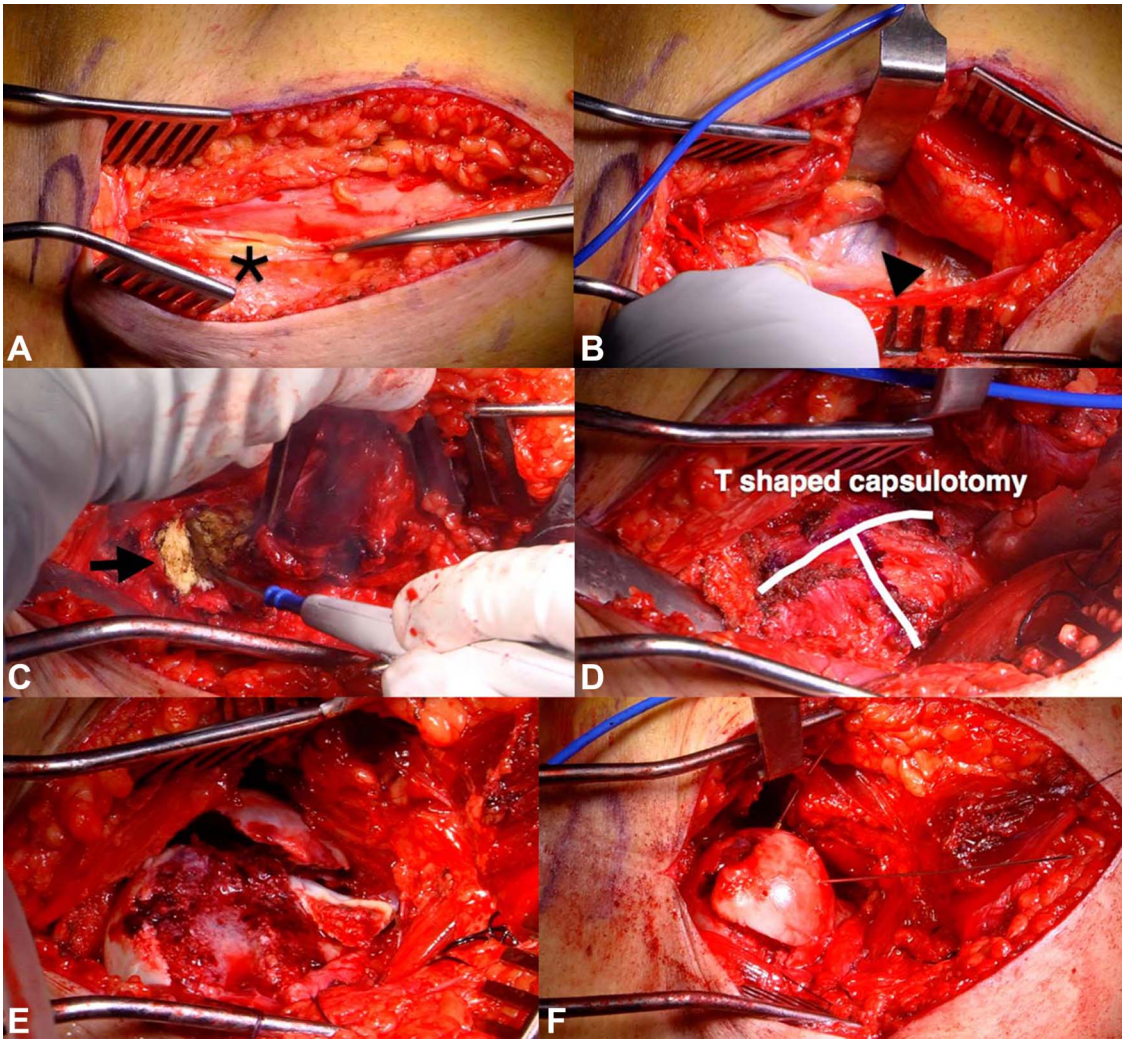

FIGURE 2. Shows the sequence of performing the modified Heuter approach for ORIF of a type II Pipkin femoral head fracture. *Lateral cutaneous nerve of thigh. The arrowhead shows the branches of the lateral circumflex artery, which needs to ligated. The arrow shows the tenotomy of the direct head of rectus femoris. **Editor's Note**: A color image accompanies the online version of this article.

reduction. Patients with displaced fractures and/or incongruent hip joint were considered for operative treatment. ORIF was performed for all Pipkin II injuries. Pipkin I fractures were either fixed or excised depending on fragment size. Patients with type III and IV injuries were excluded. In our series, all patients before 2012 were operated with the SD,

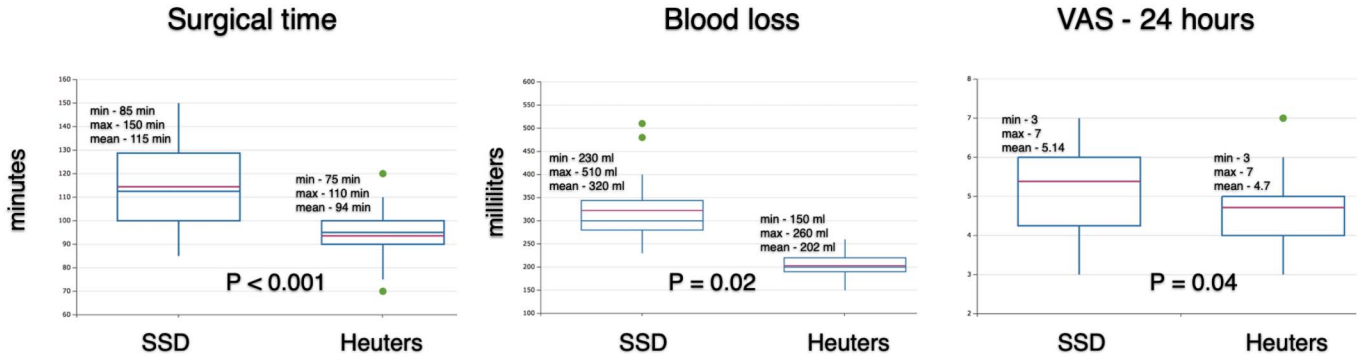

FIGURE 3. Box plots with *P* values showing the significantly lower surgical time, blood loss, and early postoperative pain scores with the modified Heuter approach over the SD. **Editor's Note**: A color image accompanies the online version of this article.

whereas the Heuter approach was our preferred choice in the later part of the study period (see **Table**, **Supplemental Digital Content 1**, http://links.lww.com/JOT/B141 for patient and fracture related data).

SURGICAL TECHNIQUE

In the SD group, a standard Kocher–Langenbeck approach with a trochanteric flip was performed in lateral position (Fig. 1). The fracture was exposed after dislocating the hip through a Z-shaped anterior capsulotomy. After inspecting the acetabular cavity for loose osteochondral fragments, large postero–superior labral tears if present were repaired using 3.5-mm suture anchors. Smaller postero–inferior labral tears were not considered for repair. Fracture was reduced and fixed using headless/countersunk 2.4/2-mm cortex screws. The capsulotomy was repaired, and the osteotomy reduced and fixed using 3.5-mm cortex screws (see **Video**, **Supplemental Digital Content 2**, http://links.lww.com/JOT/B142 demonstrating the key surgical steps in a SD).

In the Heuter group, patients were operated supine with a small triangle under the knee to relax the anterior pelvifemoral muscles. Incision was made just distal and lateral to the anterior superior iliac spine to expose the plane between tensor fascia lata and the sartorius. The branches of the lateral circumflex femoral vessels were ligated, and the tendon of the direct head of rectus femoris was tenotomized. A T-shaped anterior capsulotomy was performed, and the head was dislocated (Fig. 2). Fracture reduction and fixation was performed using standard techniques. The capsulotomy was repaired, followed by end to end repair of the tenotomized rectus tendon (see **Video**, **Supplemental Digital Content 3**, http://links.lww.com/JOT/B143 that shows ORIF of a type II fracture using a modified Heuter approach).

Follow-up and Assessment

In the initial part of the study, all patients postsurgery were allowed toe-touch weight-bearing for 6–8 weeks, followed by progression to full weight-bearing by 12 weeks. In the later part of the study, patients with type I infrafoveolar fractures were allowed weight-bearing as tolerated from day 1. Thromboembolic prophylaxis was administered in all patients for a period of 2 weeks.

Both groups were compared for surgical data, such as surgical time and blood loss. Length of hospital stay and pain scores [visual analog scale (VAS)] in the first 24 hours and at discharge were also compared. Follow-up radiological assessment was performed at 6 weeks, then at 3, 6, 12 months, and at the last follow-up. Radiographs were assessed for union at the fracture and osteotomy sites, femoral head osteonecrosis, and occurrence of degenerative changes at the hip joint. Radiological and functional outcome assessments using modified Merle d' Aubigne scores[8] and Oxford hip score[9] were performed at the last follow-up by blinded trainees who had no knowledge of the study.

Statistical Analysis

Statistical analysis was performed using StatPlus pro (version 5.4) for Mac. All continuous data were presented as mean and SD. Categorical data were presented as absolute and relative frequencies. To test the level of significance, an independent *t* test was used for continuous data and a χ^2 test for categorical data. A "*P*" value of 0.05 was considered significant.

RESULTS

A total of 49 patients, 27 in the SD group and 22 in the modified Heuter group were available for follow-up. The mean follow-up was 38.5 ± 13 months (SD group: 44 ± 15 months; modified Heuter group: 29 ± 6 months). Surgical time, blood loss, and 24 hours VAS were significantly less in the modified Heuter group ($P < 0.05$, Fig. 3). The VAS at discharge ($P = 0.07$) and the length of hospital stay ($P = 0.32$) were similar in both groups.

All fractures in both groups and the osteotomies in the SSD group had united at follow-up. No patient had developed femoral head osteonecrosis at the last follow-up. One patient

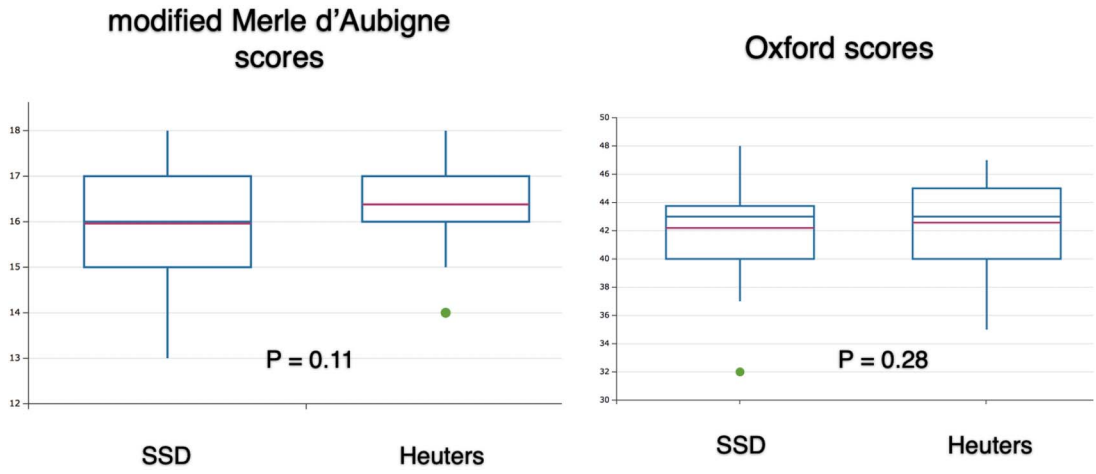

FIGURE 4. Box plots showing similar surgeon and patient reported functional outcome measures in both groups. **Editor's Note**: A color image accompanies the online version of this article.

TABLE 1. Complications

	SSD Group	Heuter Group	*P*
Nerve injuries			
LCFN	0	2	
Infection	1	0	
HO	4	2	
Brooker grade I	3	1	
Brooker grade II	1	1	
Trochanteric bursitis/implant removal	1	0	
Posttraumatic arthritis	1	1	
Total	7 (25%)	5 (23%)	0.79

in each group showed presence of degenerative changes at the hip joint. Both were symptomatic and were considering total hip arthroplasty (THA). Modified Merle d'Aubigne and Oxford functional scores at the last follow-up were similar in both groups ($P > 0.05$, Fig. 4). The Oxford scores were also similar across fracture subtypes—Pipkin I or II ($P = 0.47$) irrespective of the treatment modality—ORIF or fragment excision ($P = 0.72$).

Complications

Two cases of numbness related to the lateral cutaneous nerve of thigh (LCFN) were seen in the modified Heuter group that did not resolve spontaneously. Although it became better over a period of time, both patients still complained of sensory blunting at the last follow-up. One early wound infection was encountered in the SD group that was managed successfully retaining the implants. Degenerative arthritis of the hip joint was seen in 2 patients, one in each group. One patient in the SD group had symptomatic trochanteric bursitis, which resolved after bursal sac excision and screw removal. According to Brooker classification,[10] 6 patients had heterotopic ossification (HO), 4 in the osteotomy group and 2 in the modified Heuter group (Table 1). The overall incidence of complications was similar in both groups ($P = 0.79$).

DISCUSSION

Pipkin fracture dislocations are relatively rare injuries, which benefit from early joint reduction, accurate fracture reduction and stable fixation for restoring joint congruity, and early mobility of the hip joint. Several authors have reported successful results in previously published reports. Posterior-based and anterior-based surgical approaches; ORIF and fragment excision; and use of headless screws, countersunk mini screws, bioabsorbable pins have all been described with successful outcomes.[11–13]

The general consensus based on previously published clinical studies is that an anteriorly based surgical approach is preferable to avoid or minimize further compromise to the femoral head blood supply. However, this is not clearly established and good results with the posterior approach have been reported even in recent studies.[14] Both the SD and the modified Heuter approach have been shown to be reproducible in terms of surgical technique and reliable in terms of long-term results.[15,16] The modified Heuter approach is completely anterior based, whereas the SD is a lateral-based approach, although it uses an anterior capsulotomy made possible by the trochanteric osteotomy. During SD, care still needs to be taken during the surgical approach and performing the osteotomy to make sure there is no disturbance to the arterial supply of the femoral head.[17]

The advantage of SD is that it allows 360 × exposure of the hip joint to deal with associated fractures of the acetabulum. SD allows possible repair of posterosuperior labral tears, which are seen, in more than 50% of these fractures.[7] In our previous study, we had shown that patients who had presence of a labral tear had inferior clinical outcomes, although we could not show that labral repair helped improve outcomes or decide which labral tears need repair.[7] However in this study, we could not quantify the incidence of labral tears in the Heuter group, but the clinical results were similar in both groups regardless of the labral tear. Because we could not prove the importance of a labral tear in influencing outcomes, no recommendation could be made for a preoperative MRI to decide on the surgical approach based on this and the previous study.

We started using the modified Heuter approach for Pipkin fractures as a personal preference after we found it comfortable for performing hip arthroplasties. No specific reason or limitation can be cited against SD for the change in our preference. The modified Heuter approach has the advantage of being performed in supine position providing direct access to the anterior fracture fragments. Sometimes it is even possible to fix the fracture without dislocating the hip joint. It also has fewer surgical steps, which explains the shorter surgical time, blood loss, and possibly better early postoperative pain scores. The rectus tenotomy helps overcome the tethering effect of the strong anterior musculature providing a better exposure to perform the capsulotomy and also to dislocate the hip easily. THA if required in future can be performed through the same surgical approach. Avoiding a trochanteric osteotomy can also prevent intraoperative problems during THA.

Two patients in our study had permanent problems due to possible injury to the LCFN. We used a more lateral-based vertical incision in all our patients to avoid the problem, but the nerve course is highly variable[18,19] and is susceptible to injury during the surgical approach or due to prolonged retraction. The incidence in our study was 9%. We saw more incidence of HO in the SD group probably related to elevating the gluteus minimus from the ilium. We made sure any friable or contused muscle was excised at the end of the procedure and the wound was thoroughly lavaged to remove all bone debris created during the osteotomy. HO was seen to a lesser degree in the Heuter group because muscular damage is often minimal with the approach. This is contrary to older published outcome with the classic Smith-Peterson approach but in accordance with the more recent results.[14,20] The severity of HO was however mild (Brooker grade I or II) in both groups and did not interfere with function. We used nonsteroidal anti-inflammatory drugs (NSAIDS) for postoperative pain relief in both group of patients for a period of 2 weeks, which may have also helped in minimizing the severity of HO in these patients.

The retrospective design is a major limitation of the study. This makes interpretation and validation of results difficult and inconclusive. In this study, most of the patients (22/27) in the SD group are from our previous study cohort who had undergone closed reduction of the hip joint within 6 hours of injury, followed by a planned ORIF. The timing of hip reduction was highly variable in the modified Heuter group where more than 50% of the patients had their hip reduced after 6 hours of injury. This delay did not have a negative effect as seen by absence of femoral head osteonecrosis in both groups. However, the follow-up duration in the modified Heuter group is short compared with the SD group thereby making the validity of this comparison questionable. We had repaired postero–superior labral tears in 13 of the 27 patients in the SSD group. This could have led to an increased surgical time and blood loss in the SD group. This parameter was not analyzed in the study because the modified Heuter approach does not permit a posterior labral repair. The labral repair in the SD group did not influence the results as evident by the similar functional hip scores in both groups at the last follow-up. This was contrary to our previous results[7] where we had shown labral injury is associated with poor outcomes, although it was not an independent predictor. This retrospective study is the first to compare SD and the modified Heuter approach for surgical treatment of femoral head fracture dislocations.

There was a definite surgeon bias in this study. We started to perform the modified Heuter approach as an attempt to introduce it into our practice and not as a better alternative to SD. However gradually with experience and outcome that also reflects in our study results, we have started to prefer the modified Heuter approach for treating Pipkin I and II injuries on basis of advantages cited with the approach over SD and also to avoid some of the possible but rare issues seen with SD, such as the Avascular necrosis of the femoral head, osteotomy nonunion (especially in smokers), irritation and bursal inflammation from the implant used to fix the osteotomy, and also avoid interference of the implant in case a hip arthroplasty is needed in future.

CONCLUSIONS

Both SD and the modified Heuter anterior approach are effective in the treatment of Pipkin type I and II femoral head fractures in terms of fracture union, long-term hip function, and occurrence of complications. The modified Heuter approach is associated with a shorter operative time, less blood loss, and better early postoperative pain scores.

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