Orthopaedics & Traumatology: Surgery & Research 100 (2014) 967–970

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Technical note

The submuscular sliding plate technique for acetabular posterior wall fractures extending to the acetabular roof☆

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ARTICLE INFO

Article history:
Accepted 9 September 2014

Keywords:
Acetabulum
Acetabular fracture
Posterior wall
Acetabular roof
Technique

ABSTRACT

There is extension of the Kocher-Langenbeck approach using trochanteric osteotomy for posterior wall fracture extending to acetabular roof, but it exposes to complications such as nonunion, breakage, and heterotopic ossification. The current study introduces a submuscular sliding plate technique. We retrospectively analyzed 13 patients treated with this technique. It is based on conventional method for posterior wall fracture. After reduction of roof fragment with direct visualization, a pre-contoured plate was passed through a submuscular tunnel under the gluteus medius and minimus. A small split incision was performed on the muscles, and screws were inserted with a triple trocar complex safely under fluoroscopic imaging. All patients had fracture union without complications. X-rays results showed anatomical reduction in 10 cases and imperfect reduction in 3 cases. Our results were satisfactory, particularly without heterotopic ossifications despite no prophylactic regimen of NSAID was applied and no neurological complications, so we believe that this technique is a good option for posterior wall fractures extending to the acetabular roof.

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1. Introduction

Posterior wall fractures are the most common type of acetabular fractures, accounting for approximately 35–47% of such fractures [1,2]. Kreder et al. [1] reported that posterior wall fractures involved the acetabular roof in 3.76% of cases. Comminuted fractures with more than 3 fragments or extensions to the acetabular roof are correlated with a poor prognosis [3].

The optimal treatment for displaced posterior wall acetabular fractures is surgery, and various fixation methods such as reconstruction plates and spring plates have been introduced. Kocher-Langenbeck approach is standard for posterior wall fracture, but there is a limit to access acetabular roof [4]. Therefore, the surgical exposure to allow fracture reduction and hardware placement commonly requires a trochanteric osteotomy or vigorous muscle retraction to expose the acetabular roof and posterior wall, and these can cause abductor weakness, superior gluteal nerve damage, heterotopic ossification and nonunion of the greater trochanter [4–13]. Trochanteric flip osteotomy is commonly used for extended fracture and appears safer, but complications also occur (trochanteric nonunion, heterotopic ossifications) [4].

This study introduces the submuscular sliding plate technique (SSPT) for posterior acetabular wall fractures extending to the acetabular roof without flip osteotomy to avoid related complications and to minimize damage to the gluteus medius and minimus muscles.

2. Surgical technique

The patient was positioned in the lateral decubitus position on a radiolucent operating table that allowed easy access of the C-arm image intensifier. The incision is basically same to Kocher-Langenbeck approach. The fascia lata was incised and the gluteus maximus muscle split. The piriformis muscle and obturator internus muscle were released from their insertion. After retracting those muscles, the acetabular posterior wall and gluteus medius muscle could be seen. The displaced fragment of the posterior wall and roof was reduced anatomically under direct visualization and held temporarily using K-wires. The overall fixation was neutralized by application of a 3.5 mm reconstruction plate which was pre-contoured to the shape of the posterior wall using a sawbone

☆ This work was supported by the 2013 Inje University Research grant.

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http://dx.doi.org/10.1016/j.otsr.2014.09.020
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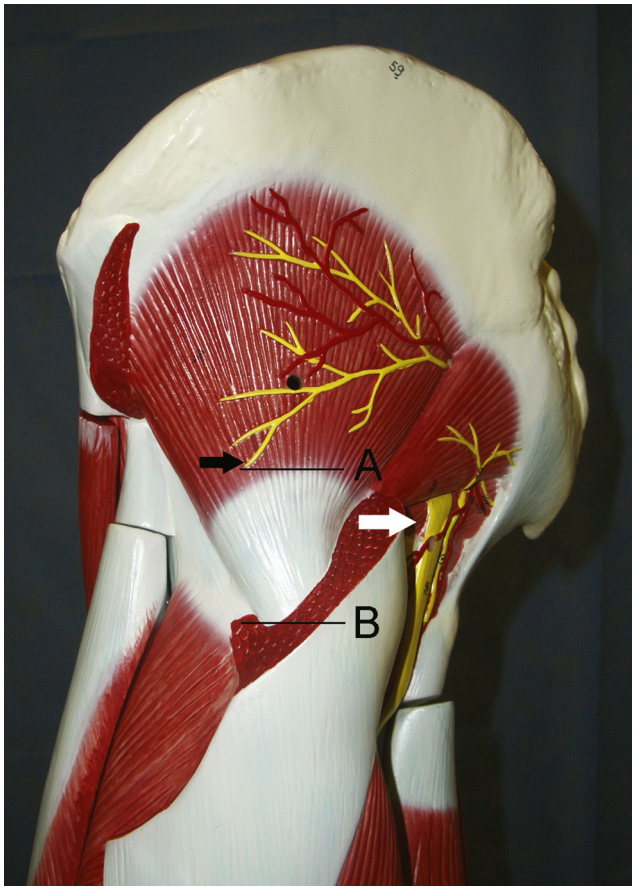

Fig. 1. Lateral schematic view of the left hip. The black arrow indicates the superior gluteal nerve and the white arrow shows the sciatic nerve. The distance between A (superior gluteal nerve) and B (trochanter tip) is at least 3 cm.

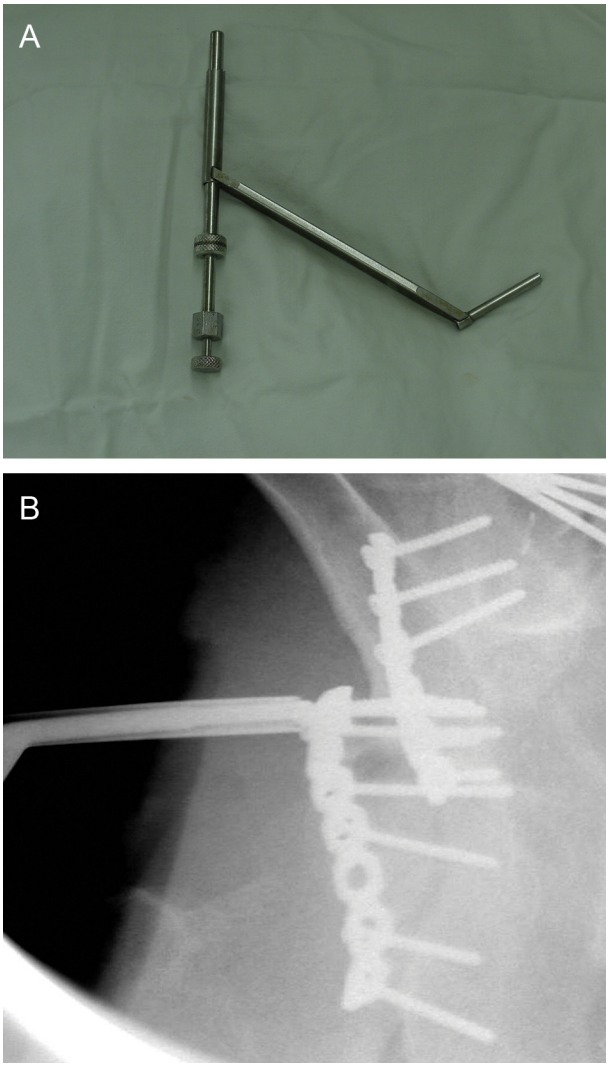

Fig. 2. A. The triple trocar complex is a combination of a 6.5/3.5 double drill guide with a 6.0/5.0 drill sleeve, 5.0/3.5 long drill sleeve and 3.5 mm long trocar (Synthes™). B. Fluoroscopic image showing the submuscular plate fixed by a 3.5 mm cortical screw through the 6.0/5.0 drill sleeve.

model and 3D reconstruction image of fractured acetabulum, which provided fracture analysis and enabled homologous plate molding to the operated pelvis. The plate was long enough to cover the entire posterior wall and acetabular roof and was slightly under-bent so it could press into and buttress the fragment. A submuscular tunnel under the gluteus medius and minimus muscle was prepared from the posterior wall to the antero-inferior iliac spine using a Cobb elevator. After confirming the location of the plate by fluoroscopy, a small split incision was performed on the gluteus medius muscle within 3 cm superior to the greater trochanter to avoid the superior gluteal nerve and vessel (Fig. 1). Positioning screws were inserted toward the inner surface of the iliac wing with a triple trocar complex. A triple trocar complex is a combination of a 6.5/3.5 double drill guide for insertion of 3.5 mm screws holing with a screw driver, 6.0/5.0 drill sleeve for tapping, 5.0/3.5 long drill sleeve for drilling and 3.5 mm long trocar (Synthes, Solothurn, Switzerland) (Fig. 2). A triple trocar supplied protection from neurovascular structures, stabilization of drilling, and accurate guide of 3.5 mm cortical screws in gluteus medius and minimus muscles. Intraoperative fluoroscopic images were used finally to evaluate the accuracy of reduction and the position of the screws and implant (Fig. 2).

3. Patient series

We retrospectively analyzed the patients treated for posterior wall fractures extending to the acetabular roof from an institutionally-approved, single-center orthopedic database between 2001 and 2004. During this period, 196 patients underwent surgery for acetabular fractures including 84 posterior wall fractures. Among 84 posterior wall fractures, 13 patients enrolled. We used SSPT for all of those patients to avoid trochanter osteotomy and vigorous muscle retraction. The mean follow-up was 5 years (minimum 1 year), based on x-ray and CT study. The average patient age was 48.6 years (range; 24–68). The time from injury to operation was an average 10 days (range; 2–32 days). The fractures pattern was described in Table 1.

The mean operation time was 199 min (range 110–375). Prophylactic indomethacin was not used. Two patients had sciatic nerve palsy after injury, but no iatrogenic neurovascular injury occurred. Union was achieved in all patients, and the mean union time was 11.1 weeks (range 10–13). There was no heterotopic ossification, or avascular necrosis of the femoral head (Fig. 3). Major complications comprised 1 case of delayed infection at postoperative 14 months and 2 cases of post-traumatic osteoarthritis including one case of subsequent arthroplasty.

The radiologic results showed anatomical reduction in 10 cases (Fig. 3) and imperfect reduction in 3 cases with the criteria of Matta [11] using postoperative computed tomography. The D'Aubigne and Postel functional score [14] was excellent in 3 cases, very good in 2 cases, good in 2 cases, and fair in 6 cases. The mean Harris Hip Score [15] at postoperative 1 year was 85.5 (61–98).

Table 1
Extension of the acetabular fracture & location of the plate fixation.

Case	Fracture classification[a]	Fracture type[b]	Posterior dislocation	Preoperative fracture gap (mm)	Postoperative fracture gap (mm)	Matta's criteria	Complications
1	PW	C	No	12	0	Anatomical	
2	PW	C	Yes	17	0	Anatomical	
3	PW	C	Yes	25	0	Anatomical	
4	PW	C	No	31	1	Anatomical	
5	PW	C	No	14	0	Anatomical	
6	PW	C	Yes	43	1.5	Anatomical	
7	PW + PC	C	No	15	2	Imperfect	
8	PW + PC	C	Yes	13	2	Imperfect	Delayed infection
9	PW	S	Yes	21	0	Anatomical	
10	PW	S	No	6	0	Anatomical	
11	T + PW	C + I	No	15	2	Imperfect	Post-traumatic osteoarthritis
12	PW	C	Yes	26	0	Anatomical	Post-traumatic osteoarthritis
13	PW	C	Yes	8	0	Anatomical	

PW: posterior wall; PC: posterior column; T: transverse; C: comminution; I: impaction; Fx: fracture.
[a] According to the Letournel-Judet classification.
[b] According to the OTA classification.

4. Discussion

A number of techniques have been employed to expose the acetabular roof and posterior wall [16]. Baumgaertner [17] reported that the prone position of the Kocher-Langenbeck approach was preferred if there was an extensive posterior wall fracture with gross instability or if the fracture involved the roof of the acetabulum, because the prone position decreased the risk of stretch injury to the sciatic nerve. However, the prone position is not possible in some patients with facial bone fractures or open abdominal wounds, and the detachment and retraction of gluteus muscles are still required. Kinik and Armangil [10] reported that extensile triradiate approach provided good visualization and direct reduction of combined acetabular fractures, but

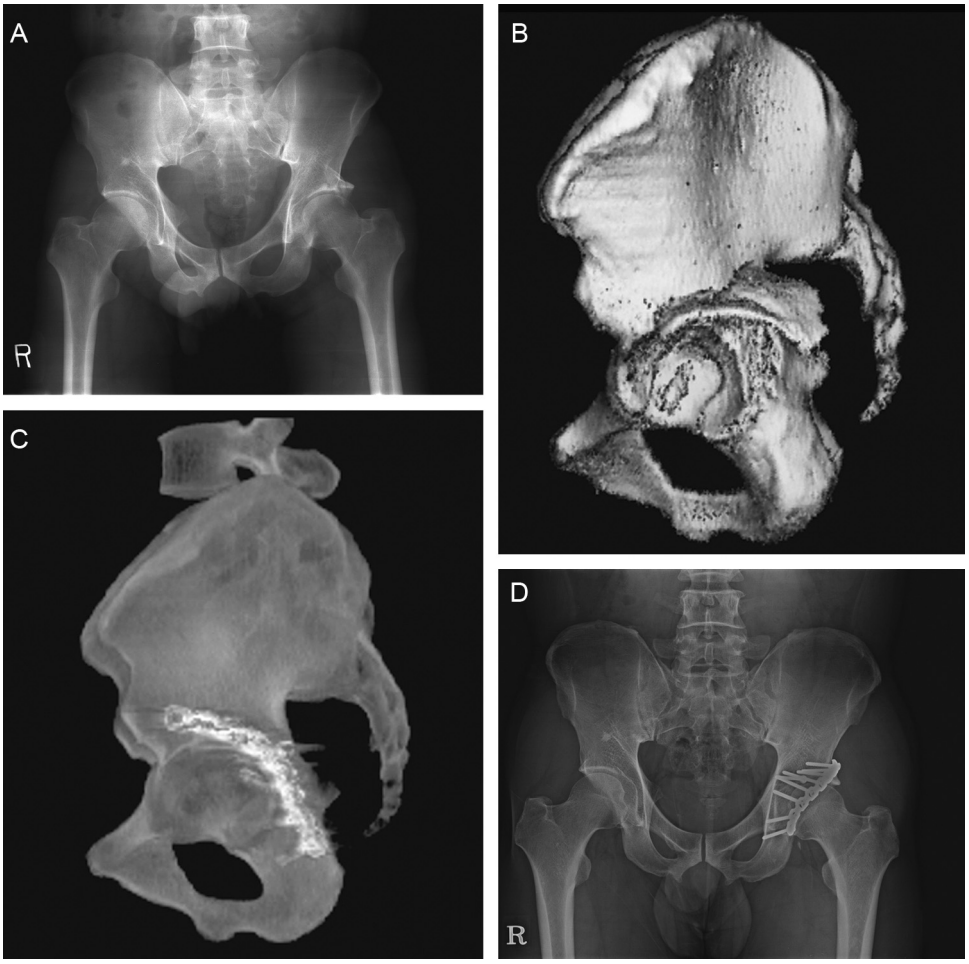

Fig. 3. An example case showing use of the submuscular sliding plate technique for an acetabular wall fracture extending to the acetabular roof. Preoperative anteroposterior x-ray (A) and 3D CT (B) of the pelvis showing a posterior wall fracture extending to the acetabular roof. C. Postoperative 3D CT image demonstrating appropriate coverage of the acetabular roof and posterior wall by the plate. D. A 7-year postoperative x-ray showing a good radiological result and no evidence of osteoarthritic change.

heterotopic ossification developed despite indomethacin prophylaxis in 5 patients (20%). To avoid radical exposure of the gluteus muscle, the trochanter osteotomy technique was introduced, but this technique has the disadvantages of nonunion of osteotomized sites and avascular necrosis of the femoral head [4,9,18,19]. Heck et al. [9] reported one case (1.8%) of nonunion, 2 cases (3.6%) of partial avulsion or migration of the trochanter, and 5 cases (9.1%) of heterotopic ossification after using the traditional trochanteric osteotomy technique. Siebenrock et al. [4] introduced the trochanteric flip osteotomy for cranial extension and muscle protection in acetabular fracture fixation, and this technique allowed free access to the postero-superior and superior acetabular wall area. They reported 2 cases (20%) of Brooker class 2 heterotopic ossifications, and all cases showed union of the osteotomy site. However, Lindgen and Stevenson [19] reported 2.1% of nonunion and Courpied et al. [18] reported 2.5% of nonunion at the osteotomy site. With less vigorous retraction and less iatrogenic damage to abductor muscles after a trochanteric osteotomy, the rate of significant heterotopic ossifications might be reduced [5,7,11,13].

In the SSPT, there is minimal retraction of the gluteus muscles without detachment, and heterotopic ossification consequently does not develop. The SSPT does not provide extended visualization of the acetabular roof, because it does not detach gluteus muscles. Reduction of acetabular roof was performed with direct visualization, but the fixation of the acetabular roof was somewhat difficult in this limited space. We adopted concept of minimal invasive plate osteosynthesis for fixation of acetabular roof. However, there is limitation in case of bone graft for impacted roof fractures in this technique.

In this technique, possible risk is injury to the superior gluteal nerve and vessels, which can cause abductor weakness. Bos et al. [20] underlined proximal extension of this transgluteal incision should be limited to 3 cm cranial to the greater trochanter. We did a small split incision on the gluteus medius muscle within 3 cm cranial to greater trochanter. In addition to anatomical consideration, we used a triple trocar complex to protect neurovascular structures.

The current study showed 15% of imperfect reduction and 46% of fair functional outcomes. We evaluated the radiological result with CT, which revealed more accurately than plain radiograph. In addition, it should be considered that most of the fractures were complex fractures when considering the outcomes.

We have described a technique to fix acetabular roof fractures, which resulted in satisfactory radiologic outcomes without complications. Therefore, we believe that the SSPT is a good option for treating posterior wall fractures extending to the acetabular roof.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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