Orthopaedics & Traumatology: Surgery & Research 105 (2019) 889–893

Contents lists available at ScienceDirect

Orthopaedics & Traumatology: Surgery & Research

journal homepage: www.elsevier.com

Technical note

Management of anteromedially displaced acetabular fractures using a collinear reduction clamp through modified ilioinguinal approach

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ARTICLE INFO

Article history:

Keywords:
Acetabular fracture
Anteromedially displaced
Modified ilioinguinal approach
Collinear reduction clamp

ABSTRACT

The authors present a surgical technique using a collinear reduction clamp through the modified ilioinguinal approach (MIA) for anteromedially displaced acetabular fractures along with the surgical outcomes. Between October 2010 and June 2015, 15 patients underwent surgical treatment for anteromedially displaced acetabular fractures; 10 both-column fractures and 5 anterior column and posterior hemitransverse fractures. Anteriorly displaced anterior column fragment and medially displaced quadrilateral plate fragment were simultaneously reduced using a collinear clamp and fixed with a 3.5mm-reconstruction plate through MIA. Postoperatively, anatomical reduction was achieved in 12 patients, while imperfect reduction was achieved in 3. At a mean follow-up of 49.0 months (range, 24–93 months), the mean Postel Merle d'Aubigné score were 16.3 and the mean VAS score was 0.9. Final radiographic grades according to Matta system were excellent in 13 patients and good in 2. Surgical technique using a collinear reduction clamp through the MIA can provide satisfactory outcomes in anteromedially displaced acetabular fractures.

1. Introduction

Treatment of anteromedially displaced acetabular fractures can be more challenging because of two-directionally displaced fracture components and their close proximity to neurovascular structures. Although it was not specifically classified as a single type according to the Letournel and Judet classification system, a new effort to classify it as a single type has been tried, recently [1]. This fracture type involves both an anteriorly displaced anterior column component and a medially displaced quadrilateral plate component [2]. Therefore, the selection of an appropriate surgical approach and reduction method is of paramount importance to achieve a satisfactory surgical outcome for this fracture type.

The modified ilioinguinal approach described by Karunakar et al. [3], which combines features of the conventional ilioinguinal approach and the modified Stoppa approach, can provide a sufficient surgical field up to the iliac wing, medial wall of the acetabulum, and pubic symphysis. Therefore, this approach provides great advantages for obtaining adequate reduction and fixation in anteromedially displaced acetabular fractures even with fracture extension into the iliac wing and sacroiliac joint.

A collinear reduction clamp (Synthes®, West Chester, PA, USA) may be a good option for reducing anteromedially displaced acetabular fractures. This device can reduce two-directionally displaced fracture components simply and maintain the reduction status simultaneously during the definite fixation. It also has advantages of providing a compression force at the fracture site via squeezing the trigger and being easy to handle in a limited space.

This study aimed to report the surgical outcomes of anteromedially displaced acetabular fractures reduced with a collinear reduction clamp through the modified ilioinguinal approach (MIA). The current study hypothesized that modified ilioinguinal approach and the collinear reduction clamp are available to treat this fracture type.

2. Surgical technique

Surgery was performed with the patient in the supine position on a radiolucent imaging table (Radiolucent Imaging Top®, Mijuho OSI, CA, USA) with manual traction according to the original descriptions of Karunakar [3]. A complete modified Stoppa approach, as described by Cole and Bolhofner [4], was performed

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https://doi.org/10.1016/j.otsr.2018.10.004
1877-0568/

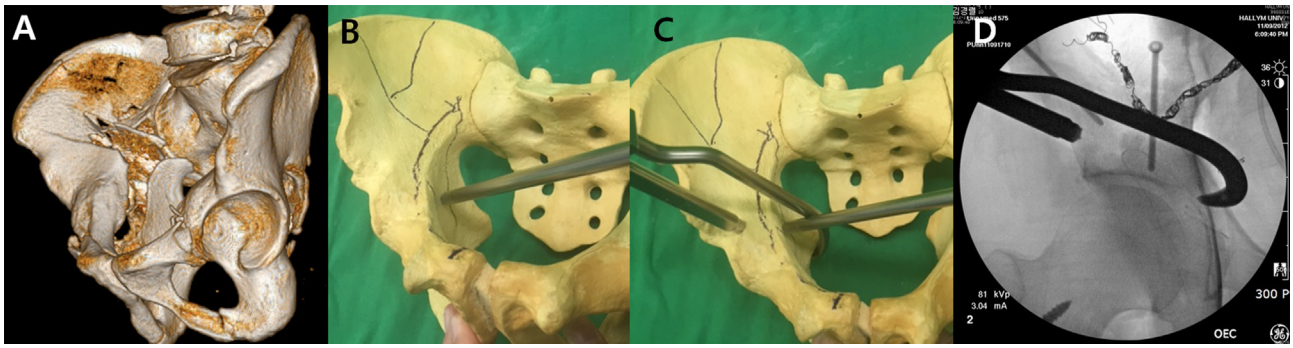

Fig. 1. (A). Anteromedially displaced both-column fracture. Photos showing the reduction steps in this fracture type. (B). Reduction of medially displaced quadrilateral plate component by a ball spike pusher through the medial window. (C). Then, indirect reduction of anteriorly displaced anterior column component by advancing the feed rod of a collinear reduction clamp placed through the lateral window. (D). Intraoperative fluoroscopic view showing anteromedially displaced acetabular fractures reduced and maintained by a collinear reduction clamp.

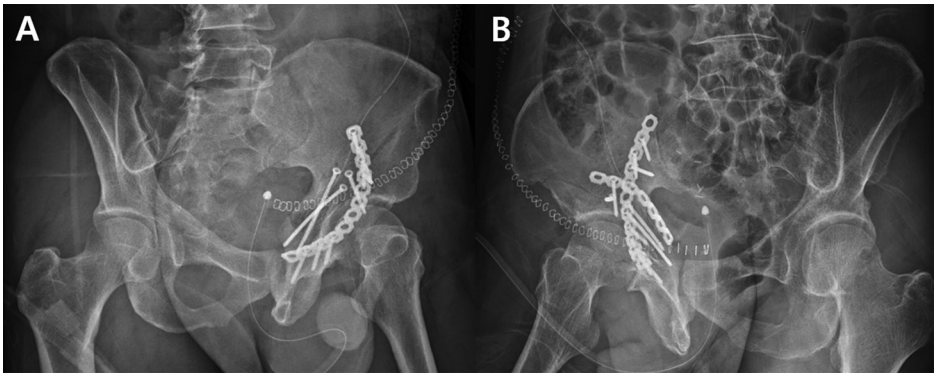

Fig. 2. Two fixation methods are used for anteromedially displaced acetabular fractures. (A). Two 3.5-mm cortical screws as a lag screws from the anterior pelvic brim toward the ischial spine or (B) over-contoured 3.5-mm reconstruction buttress plate.

for the medial window. The surgical approach for the middle and lateral windows was performed according to the conventional ilioinguinal approach [5]. The middle window was used for the accurate reduction of anterior column and placement of anterior brim plate. However, it was not necessary to completely open the inguinal ligament and dissect around the femoral vessels and lymphatics while making the middle window unlike the conventional ilioinguinal approach. The site of the surgeon was on the ipsilateral side of the fracture site during the procedures. In anteromedially displaced acetabular fractures with the iliac wing fracture component (Fig. 1A), which accurate reduction and fixation is first necessary for, direct reduction and fixation with 3.5-mm reconstruction plates or cortical screws was performed through the lateral window. After a sufficient surgical field was obtained, direct reduction of the medially displaced quadrilateral plate component was obtained by pushing it laterally with a ball spike pusher with or without a disc through the medial window (Fig. 1B). After satisfactory reduction was achieved, a collinear reduction clamp was placed through the lateral window and the pelvic arm was hooked under the ischial spine under 2D fluoroscopic guidance (Fig. 1C). Then, the feed rod of this clamp was placed at the anterior pelvic brim and advanced by squeezing the trigger while removing the bone pusher. By doing so, direct reduction and compression at the anteromedially displaced fracture sites could be simultaneously achieved (Fig. 1D). The fixation method for the medially displaced quadrilateral plate component was selected according to fracture pattern and bone quality. Two 3.5-mm cortical screws as a lag screw from the anterior pelvic brim toward the posterior column were used in relatively younger patients (12/15) without comminution at the anterior pelvic brim, while the buttress plate using a 3.5-mm reconstruction plate or T-plate, which is over-contoured with a sharp angle of approximately 80° at its proximal one-third, was used in older patients or those with comminution at the anterior pelvic brim (3/15) (Fig. 2). Then, the pelvic brim plate using a 3.5-mm curved reconstruction plate was contoured and the additional fixation for anteriorly displaced anterior column component was performed along the pelvic brim using this plate. In four patients with a posterior wall fracture component, additional fixation was performed through the Kocher-Langenbeck approach 1 week after anterior fixation was achieved.

After surgery, non-weight bearing on the operated side was maintained for about 4 weeks; thereafter, tolerable weight bearing with a pair of crutches was allowed. Full weight bearing was permitted about 10 weeks after surgery depending on the degree of radiographic fracture consolidation.

3. The series

3.1. The series

Between October 2010 and June 2015, 15 consecutive patients with anteromedially displaced acetabular fractures were operated using a collinear reduction clamp through the MIA.

The study group included 13 men and 2 women with a mean age of 47 years (range, 22–65 years). According to Letournel and Judet classification, there were both-column fracture in 10 patients and anterior column and posterior hemitransverse fracture in five patients (Table 1). The average time of operation was 216 minutes (range, 125∼285 minutes). The quality of reduction for the articular surface and the congruency of the hip joint were evaluated by postoperative plain radiographs using the Matta classification system of anatomic (0–1 mm), imperfect (1–3 mm), and poor (> 3 mm) [6].

Table 1
Data for 15 patients with anteromedially displaced acetabular fracture.

Case	Gender	Age	Fracture type	Injury mechanism	Associated injuries
1	Male	29	ACPH	In-car RTA	
2	Male	43	ACPH	In-car RTA	Ipsilateral ulnar fracture
3	Male	41	BC	In-car RTA	
4	Female	54	BC	Fall more than 3 meter	
5	Female	26	ACPH	In-car RTA	
6	Male	57	BC	Pedestrian RTA	
7	Male	38	BC	In-car RTA	
8	Male	57	ACPH	Fall less than 3meter	
9	Male	53	BC	Fall more than 3 meter	
10	Male	49	ACPH	Fall more than 3 meter	
11	Male	65	BC	Fall less than 3 meter	
12	Male	61	BC	Fall less than 3 meter	Ipsilateral distal radius fracture
13	Male	49	BC	Fall more than 3 meter	Ipsilateral distal radius fracture
14	Male	56	BC	Fall less than 3 meter	
15	Male	22	BC	In-car RTA	

BC: both column fracture; ACPH: anterior column and posterior hemitransverse fracture; RTA: Road traffic accident.

Table 2
Postel Merle d'Aubigne (PMA) score [7].

Score	Pain	Mobility			Ability to walk
		No joint contracture	Joint deformity in		
		Mobility in flexion	Flexion; external rotation	Abduction; adduction; internal rotation	
0	*Pain is intense and permanent*		Deduct 1 point	Deduct 2 points	Impossible
1	*Appearing during walking after* Immediately				Only with crutches
2	Before 10 minutes	< 30°			Only with two canes
3	10 to 30 minutes	30°~50°			Limited with one cane (less than one hour). Very difficult without a cane
4	30 minutes to 1 hour	50°~70°			Prolonged with one cane; limited without a cane (limp)
5	*Rare and mild*	70°~90°	None	None	Without a cane but slight limp
6	*No pain at all*	≥ 90°	None	None	Normal

At the final follow-up, the Postel Merle d'Aubigne (PMA) score (Table 2) [7] and visual analog scale (VAS) score were used to rate the final clinical outcome. The radiological evaluation was performed based on Matta criteria as follows: excellent (normal-appearing hip joint), good (mild changes with minimal sclerosis and joint narrowing < 1 mm), fair (intermediate changes with moderate sclerosis and joint narrowing < 50%), and poor (advanced changes) [6].

3.2. Results

All patients were followed up for a minimum of 2 years with a mean 49.0 months (range, 24–93 months). Anatomical reduction of the acetabular fracture was achieved in 12 patients and imperfect reduction was achieved in 3 patients on plain radiographs.

At the final follow-up, radiographic grades were excellent in 13 patients (Fig. 3) and good in 2. The mean PMA score was 16.3 (range, 14–18), while the mean VAS score was 0.9 (range, 0-3) (Table 3).

Regarding complications, foot drop and weakness of the ipsilateral lower extremity was reported in one patient with a both-column fracture. This was ultimately diagnosed as lumbosacral plexopathy, which probably occurred during the reduction and bleeding control around the sciatic notch. At the final follow-up, he had partially recovered. In addition, one lateral femoral cutaneous nerve lesion was observed that recovered completely at 6 months' follow-up (Table 3). There were no other complications such as deep infection, deep vein thrombosis, surgical site infection, or heterotopic ossification. All patients started to ambulate without external support at mean 14.5 weeks (range, 10–20 weeks), postoperatively. In 3 cases with a concomitant ipsilateral forearm fracture, hand & wrist special surgeon operated these fractures, on the same day when the acetabular fracture was operated. These 3 patients started partial weight bearing with one crutch. No patient required or underwent conversion to total hip arthroplasty due to posttraumatic arthritis or degenerative changes.

4. Discussion

Anteromedially displaced acetabular fractures are generally caused by impaction of the femoral head into the quadrilateral surface and superomedial dome, which displaces the quadrilateral plate medially and the anterior column anteriorly. It may be difficult to obtain anatomical reduction and firm fixation without a sufficient surgical field and appropriate reduction tools in these two-directionally displaced fractures [8]. Therefore, the selection of the appropriate approach and reduction tools is of paramount importance for obtaining an accurate reduction and satisfactory long-term outcome.

The MIA based on the modified Stoppa approach eliminates the need for dissection around the lymphatics, limits the release of the inguinal ligament, and allows for easier plate passage through a larger medial window, compared with the conventional approach [3]. In addition, this larger medial window can be used for both reduction and instrumentation of the posterior column and quadrilateral surface with the limited development of the second window or without this window, which minimally compromises the integrity of the inguinal floor and reduces the risk of iatrogenic

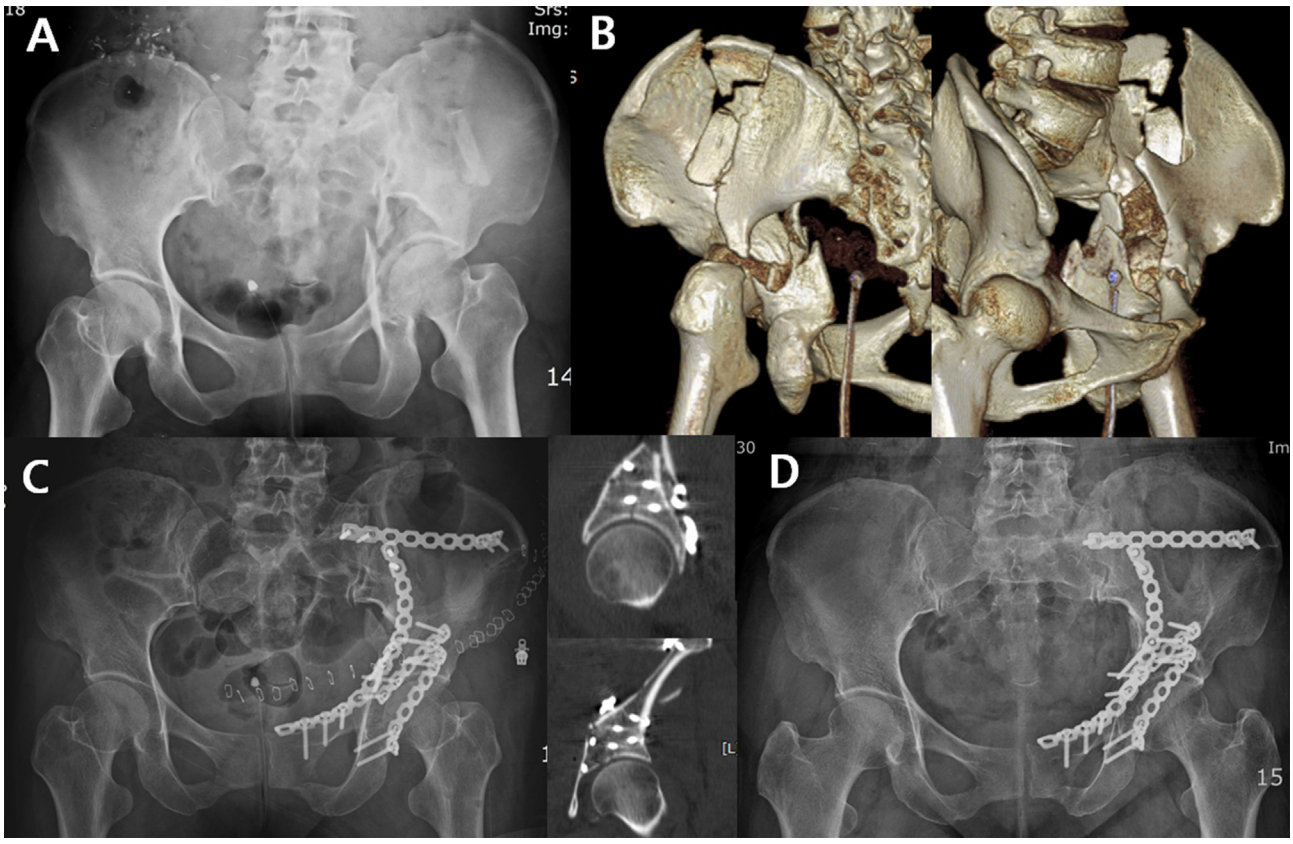

Fig. 3. (A). Pelvis anteroposterior radiograph and (B) 3-dimensional (3-D) CT of a 54-year-old female, showing an anteromedially displaced both-column fracture with a posterior wall component. (C). Postoperative anteroposterior radiograph and CTs after anterior fixation through the modified ilioinguinal approach and staged posterior fixation through Kocher-Langenbeck approach. (D). Final pelvis anteroposterior radiograph 48 months after surgery.

Table 3
Surgical treatment & outcomes.

Case	Surgical approach	Quadrilateral plate fixation method	FU period (Month)	VAS score	PMA score	Quality of reduction	Radiographic grade	Complication
1	MII & KL	Two lag screws	74	1	18	Anatomic	Excellent	
2	MII	Two lag screws	93	2	17	Imperfect	Excellent	
3	MII & KL	3.5 mm T-plate	28	0	18	Anatomic	Excellent	
4	MII & KL	Two lag screws	72	0	17	Anatomic	Excellent	
5	MII	Two lag screws	68	0	19	Anatomic	Excellent	
6	MII	Two lag screws	55	0	17	Anatomic	Excellent	
7	MII	Two lag screws	66	3	15	Anatomic	Excellent	Lumbosacral plexopathy
8	MII	Two lag screws	25	1	17	Anatomic	Excellent	
9	MII	Two lag screws	61	1	16	Anatomic	Excellent	
10	MII	Two lag screws	61	0	17	Anatomic	Excellent	
11	MII	3.5 mm reconstruction plate	32	1	16	Imperfect	Good	
12	MII & KL	3.5 mm reconstruction plate	28	2	17	Anatomic	Good	Lateral femoral cutaneous nerve lesion
13	MII	Two lag screws	24	2	17	Imperfect	Excellent	
14	MII	Two lag screws	24	1	17	Anatomic	Excellent	
15	MII	Two lag screws	24	0	18	Anatomic	Excellent	

MII: modified ilioinguinal; KL: Kocher-Langenbeck; FU: follow-up; VAS: visual analogue scale; PMA: Postel Merle d'Aubigné.

hernia. Even if anteromedially displaced acetabular fractures are more difficult to treat than only medially displaced quadrilateral plate fractures, the surgical outcomes of the current study were superior to those in previous studies that did not subdivide fracture types specifically [9–11].

In anteromedially displaced acetabular fractures, a collinear reduction clamp can be a very simple and effective tool for reducing and simultaneously maintaining two-directionally displaced anterior column and quadrilateral plate components based on the current findings. In addition, interfragmentary compression between two-directionally displaced fracture components can be achieved easily and simultaneously by sliding the feed rod of a collinear reduction clamp, thereby reducing the gap in the fracture site and achieving a congruent joint surface. It is also used as a temporary firm fixator so that no additional device or temporary fixation is necessary. We could achieve satisfactory reduction and surgical outcomes in almost all cases by using a collinear reduction clamp in this specific fracture type.

Several authors have developed new fixation strategies for medial infrapectineal buttress plates in medially displaced quadrilateral plate fractures [12,13]. However, in anteromedially displaced fractures, this solution does not provide adequate support for anteriorly displaced fracture component and can often hinder direct reduction of this component unless simultaneous reduction for two-directionally displaced fracture components is performed.

This study is limited by its small cohort size and retrospective nature despite the prospectively collected data. Also, there was no comparative group treated with other approaches or reduction instruments. However, to date, no comparative study exists in the published literature and there has been little information about this specific fracture pattern treated with this specific reduction tool and modified ilioinguinal approach. Accordingly, we believe that important information can be gleaned from this small cohort because this study included a uniform cohort of patients who sustained anteromedially displaced acetabular fracture and were treated through the same anterior approach by a single surgeon at a single institution.

We are not aware of any clinical series specifically assessing the results of the MIA using a collinear reduction clamp in anteromedially displaced acetabular fractures, although these have been used widely in the treatment of acetabular fractures. The current findings show that anteromedially displaced acetabular fractures can be treated successfully using a collinear reduction clamp through the modified ilioinguinal approach with satisfactory surgical outcomes and fewer complications.

5. Conclusion

In anteromedially displaced acetabular fractures, surgical technique using a collinear reduction clamp through the MIA for two-directionally displaced fracture components is reliable and reproducible. It leads to favorable surgical outcomes after a minimum of two years' follow-up. However, comparative studies with larger cohort and long-term follow-up, which use different approaches and reduction techniques for this fracture type, are needed to confirm our results.

Disclosure of interest

The authors declare that they have no competing interest.

Funding sources

There was no financial support for the study.

Authors' contribution

JHY planned and designed this study and wrote this article. DKK gathered data of patients and created figures and tables. CYJ and JHH wrote and reviewed this article.

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