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ORIGINAL ARTICLE

Evaluation of Outcome of Surgical Reduction and Fixation of Sacroiliac Crescent Fracture Dislocation

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ABSTRACT

Background: Crescent fractures Sacroiliac result in a rotationally unstable hemipelvis with many complications, they are characterized by the disruption of the sacroiliac joint and extend proximally as a fracture of the posterior iliac wing. Operative intervention is recommended for the anatomical reduction and stable fixation of a crescent fracture-dislocation to restore the normal anatomy. This work aims at assessing the outcome of the surgical reduction and fixation of different types of crescent fracture with follow up for one year.

Methods: Our prospective study was conducted involving 24 cases with crescent pelvic fracture. All patients were operated at Zagazig University Hospitals. All cases were surgically managed by reduction of the fractures and internal fixation either by reconstruction plates, iliosacral screws or LC-II screws. Posterior internal fixation alone was used in 13 cases, and a combination of anterior and posterior fixation was done in 11 cases.

Results: Our results revealed radiologically 21 patients were excellent, three were good according to Tornetta and Matta [8] score. Two patients complained of pain post-operatively, the same two patients had moderate ambulation problems. The postoperative infections were present in two cases. The mean Majeed score one year post-operatively was 90.7/100 for the 15 working patients, and 68/80 for the 11 non-working patients.

Conclusion: Early and anatomic reduction and fixation of crescent fracture dislocation is needed to improve results of management of this injury.

Keywords: Sacroiliac joint, crescent Fracture dislocation, Majeed score, percutaneous fixation.



INTRODUCTION

Lateral compression (LC) fractures account for more than 50% of all pelvic injuries in most series and are most commonly caused by side impacts [1], crescent fractures are defined as a vertical posterior iliac wing fracture leaving the posterior superior iliac spine and posterior sacroiliac ligaments attached to the sacrum, resulting in a rotationally unstable hemipelvis [2]. Operative intervention is recommended for the anatomical reduction and stable fixation of a crescent fracture-dislocation. Restoration of the normal anatomy should reduce the incidence of malunion, post-traumatic sacroiliac joint arthritis, painful stance phase gait cycle instability and seating obliquity [3]. Sacroiliac articular alignment is the primary factor determining the surgical approach. Besides the fracture configuration, additional factors like delay in surgery, locking of the fracture fragments, comminution of the iliac or

sacral fragment as well as access to the additional injuries contribute to the decision making. [4]. Percutaneous iliosacral (IS) screw fixation is a good option for Day's types II and III crescent fractures, with fewer complications than the plate option and less operative time. While plating should be used for type I crescent fracture [5]. Despite satisfactory reduction and stabilization, some patients may experience persistent pain and dysfunction, which is commonly observed in high-energy injuries [6]. The aim of this study is assessing the functional outcome of the surgical reduction and fixation of different types of crescent fracture with follow up for one year. Our hypothesis is that anatomical reduction is mandatory for satisfactory functional outcome.

METHODS

This study was conducted on 24 patients who sustained pelvic fracture involving the posterior ring in form of crescent fracture dislocation of the

sacroiliac joint between November 2017 and June 2020. All patients underwent surgical reduction and fixation either by open or closed techniques. The study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. All patients underwent surgery in Zagazig University Hospitals. Different forms of fixation were used including iliosacral screws, LC-II (Lateral compression type II) screws and plates for crescent pelvic injuries. In some cases internal fixation of posterior pelvic ring injuries was supplemented with reconstruction plates, anterior column screw or external fixator for associated anterior pelvic injuries to establish early weight bearing. The pelvic fractures were classified according to both Young and Tile classification system and the crescent fractures were classified according to Day et al classification. All patients were evaluated preoperatively using the standard radiographs: AP, inlet, and outlet views, and CT scan. Postoperatively, patients were followed-up for a period of 12 months and were evaluated using the Majeed [7] functional score and Tornetta and Matta [8] radiological score. Written informed consent was obtained from all participants' parents. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

STATISTICAL ANALYSIS

Data analysis was performed using the software SPSS (statistical package for the social science) version 20. Quantitative variables were described using their means and standard deviations. Categorical variations were described using their absolute frequencies and to compare the proportion of categorical data, chi square test and Fisher exact test were used when appropriate. The level of statistical significance was set at 5% ($p < 0.05$). A highly significant difference was present if $p \leq 0.01$.

RESULTS

Regarding age distribution, the youngest patient operated upon was 17 years of age at the time of surgery and the oldest was 60 years of age, with a mean age of 29.8 years with SD of 9.6 years. The study included 13 males and 11 females. Most of our patients were victims of motor vehicle accidents (MVA). Other modes of trauma had a minor contribution in our patients (Table 1). Sixteen patients had crescent fracture on the right side while eight patients had left side crescent

fracture. In our study, the pelvic fractures treated were all of the B and C-types according to the modified Tile classification. Details of the number of pelvic fractures are shown in (Table 2). According to the Young classification system all the patients were of the lateral compression (LC) and combined mechanism of injury (CMI) (Table 3) shows the number of pelvic fractures in each category. Also, Day et al type of crescent fracture distribution is shown in (Table 4).

Intra-operatively, different approaches used in our work are shown in (Table 5).

Posterior internal fixation alone was used in 13 cases of which nine cases by plating, three cases by IS screws and one case by LCII screws (figure 1). Anterior fixation was added in 11 cases (external fixator was used in five cases, symphyseal plate in five cases and retrograde anterior column screw in one case (figure 2). In our series two patients (8%) out of 24 complained of pain with normal to moderate activity improved by rest (pain score of 20 in Majeed [7] system), the same two patients had moderate limp (gait unaided item in Majeed [7] system scored 8) at the end of the study.

Postoperative infection was present in other 2 cases, both were improved with treatment.

Iatrogenic postoperative L5 root compression symptoms occurred in one case who improved after removal of IS screw five months postoperatively. It was a sufficient time for healing of the injury as there was no pelvic ring redisplacement after IS screw removal till end of follow up at one year post fixation. Our results revealed radiologically 21 patients were excellent, three were good according to Tornetta and Matta [8] score depending on residual post-operative vertical displacement.

The Majeed [7] score was used to evaluate the functional outcome of our patients one year after surgery. The mean score for the 15 working patients was 90.7/100 (range 81-98). Among those working patients, 11 patients scored Excellent, and four patients scored Good. The mean score for non-working patients was 68/80 (range from 47-78). Among them, four patients scored Excellent, four patients scored Good, and one patient scored Fair. The final functional outcomes were related more to the radiologic outcome. Complication also decreased Majeed score [7] in our patients. However, added anterior fixation had no obvious effect on final functional outcome.

Table 1: Percentage of patients according to the mode of trauma.

	Motorcycle	Motor Vehicle Accident	Pedestrian	Fall from Height
No. of patients	1	17	1	5
Percentage	4%	71%	4%	21%

Table 2: Number of pelvic fractures according to Tile classification.

	B2	B3	C-1	C-2
Number of pelvic fractures	14	4	4	2
Percentage	58%	17%	17%	8%

Table 3: Number of pelvic fractures according to Young’s classification.

	Young Classification		
	LC-II	LC-III	CMI
Number of pelvic fractures	17	4	3
Percentage	71%	17%	12%

Table 4: Percentage of fracture type distribution according to Day’s classification.

	Type I	Type II	Type III
No. of cases	13	7	4
Percentage	54%	29%	17%

Table 5: The different approaches and implants used for our patients.

Case	Approach	Used Implants
1	Lt Percutaneous IS screw	Cannulated screw 7.3 mm and washer
2	Rt Modified Stoppa approach	Reconstruction plates 4.5 mm
3	Lt anterior SI approach	Reconstruction plates 3.5 mm and contoured small DCP’s
4	Rt percutaneous IS screw, Interfragmentary screw and Pfannesteil approach	Cannulated screws 6.5, washers and Reconstruction plates 4.5 mm
5	RT Anterior SI approach and Pfannensteil approach	Reconstruction plates 3.5 mm
6	Lt anterior SI approach	Reconstruction plates 3.5 mm
7	Lt Percutaneous IS screw and anterior external fixator	Cannulated screw 6.5 mm, washer, olive external fixator
8	RT Anterior SI approach	Reconstruction plates 3.5 mm
9	RT Anterior Approach SI and anterior external fixator	Reconstruction plate 3.5 mm, olive external fixator.
10	Lt Anterior SI Approach, anterior external fixator.	Reconstruction plates 3.5 mm, olive external fixator.
11	Rt Anterior Approach to SI joint and Pfannensteil approach	Reconstruction plates 4.5 mm
12	Lt Percutaneous LC-II screws from posterior to anterior	Cannulated screws 6.5 mm
13	Lt anterior SI approach and Pfannensteil approach	Reconstruction plates 3.5 mm
14	Rt anterior SI approach	Reconstruction plates 3.5 mm
15	Lt anterior SI approach and anterior external fixator	Reconstruction plate 3.5 mm, contoured small DCP’s, interfragmentary 6.5 mm cannulated screw, olive external fixator
16	Lt anterior SI approach	Reconstruction plates 3.5 mm
17	Lt anterior SI approach	Reconstruction plates 3.5 mm
18	Rt anterior SI approach	Reconstruction plates 3.5 mm
19	Rt Percutaneous IS screws	Cannulated screws 6.5 mm and washers
20	Rt Percutaneous SI screw	Cannulated screw 6.5 mm and washer
21	Rt anterior SI approach	Reconstruction plates 3.5 mm
22	Lt anterior SI approach	Reconstruction plates 3.5 mm

Case	Approach	Used Implants
23	Rt Percutaneous IS screw and Rt Percutaneous columnar screws acetabulum	Cannulated screws 6.5 mm and washer
24	Rt anterior SI approach and Pfannesteil approach	Reconstruction plates 3.5 mm

Abbreviations: **DCP:** Dynamic compression plate **IS:** Iliosacral **Lt:** Left **mm:** millimeter **Rt:** Right **SI:** Sacroiliac

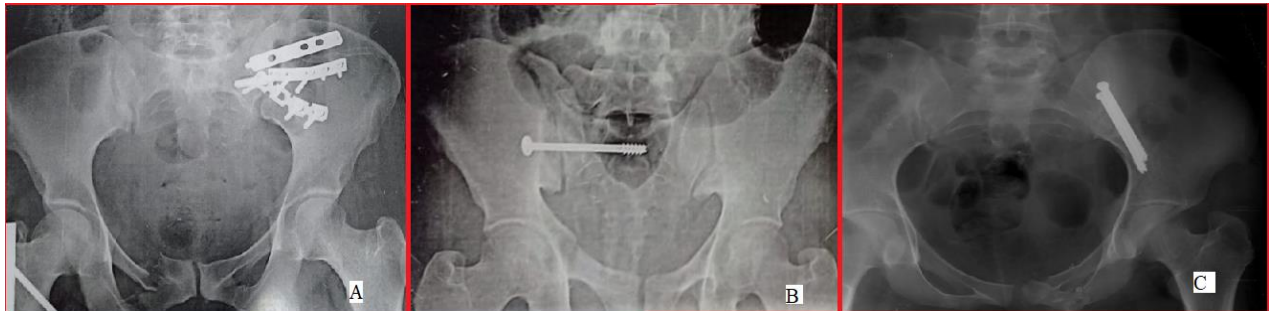


Figure 1: Post operative X ray of different types of posterior pelvic ring fixation methods in our study; A: Anterior sacroiliac plating, B: Iliosacral screws, C: Posterior to anterior LC-2 screws.



Figure 2: Different types of anterior pelvic fixation methods used in our study; A: Anterior external fixator, B: Syphyseal plate, C: Superior pubic ramus screw.

DISCUSSION

In our series, the outcome was affected by, associated injuries and disease, anatomical variation as dysmorphic sacrum, mechanism of injury, malreduction, surgical delay and complications like infection and nerve insult.

In our study, two patients out of 24 (8%) complained of pain with normal activity improved by rest, the same two patients had moderate limping. While, in Khaled et al [9] and Calafi et al [10] studies, all cases were pain free with movement. However, in Yuan et al study [11], three patients out of 14 (21%) had minimal sacroiliac joint pain and claudication with walking for long time and no special treatment was needed. In our study, only one patient of 15 previously working patients (7%) needed to change his job. Other patients returned to their job without reduced performance. Similarly, in Day et al [12], all patients returned to work with or without reduced performance. But in Starr et al [13], of the 18 patients, 16 had returned to work. In Nusser et al [14] results were reduction of employment amounting to 16.6 % for patients with a pelvic

fracture. Postoperative infection in our study was present in two cases (8%), one with pin tract infection, one with superficial wound infection, both were improved with treatment. No additional surgeries other than extraction of external fixator were needed. While in Khaled et al [9] study, the clinical results were good in all cases, no wound complications. Also, Starr et al [13] had no infection or wound complications.

Regarding iatrogenic injuries, we had iatrogenic postoperative L5 root injury in one case (4%) needed removal of iliosacral screw and it improved. It occurred in a patient with dysmorphic sacrum operated by IS screw through S1. Khaled et al [9] had no iatrogenic postoperative neurological complications. In Elkady et al study [15] on 30 cases of Day types II and III by iliosacral screws after exclusion of dysmorphic sacra there were no neurological complications. Also, Calafi et al [10] didn't report iatrogenic neurological injury in their study. However, in the series by Shui et al, [16] iatrogenic neurologic injuries were observed in 5 patients (4.3%). Elzohairy and Salama [17] reported that 1 case (1.5%) was complicated by

radiculopathy L5 root palsy after iliosacral screw insertion. In our series, Majeed [7] score of 15 patients (62.5%) were graded excellent, eight patients (33%) were graded good, and one patient (4.5%) was graded fair. Regarding Majeed [7] score, our clinical results are comparable to the work of Khaled et al [9] and Elkady et al [15] while better than Shui et al [16].

In our study, the clinical Majeed [7] score decreased in patients with associated injuries, those who suffered complications and those with less radiological outcome grade. However, Ayvaz et al [18] stated that associated injuries lower the long-term outcomes of patients having unstable pelvic ring injuries. Neurologic injuries and infection have negative detrimental effect on the outcomes. In our study, Day's type, fixation method and age had no effect on Majeed [7] score. Day et al [12] concluded also that there is no evidence that the three fracture types have different functional outcomes, and there is no obvious relationship between age and outcome. Elzohairy and Salama [17] stated that no significant difference in functional outcomes between ORIF and CRIF groups. While Shui et al [16] concluded that, compared with patients in the ORIF group, all patients in the closed reduction group achieved satisfactory radiological results and functional outcomes. This may be due to higher rate of infection, neurologic injury and lower radiologic scores in the ORIF group.

In our 24 cases and according to Tornetta and Matta [8] radiologic outcome, none had poor nor fair radiological result, 21 patients (88%) were excellent, and three patients (12%) were good. Complete union occurred in 23 cases in three to six months. In Khaled et al [9], no residual deformity of the limb, the union rate was 100%. In Starr et al [13] study, the average displacement was 3 millimeters (range, 0–10 millimeters). All patients were followed-up clinically until fracture union, except for the 2 patients lost in early follow-up. All of the pelvic fractures had healed at latest follow up. There were no non-unions.

In the series by Shui et al [16], the radiological outcomes were evaluated postoperative and after healing. The final results were excellent in 39 cases (33%), good in 49 cases (42%), fair in 24 cases (21%) and poor in 5 cases (4%). The poor results were not found postoperative but in the follow up which necessitated reoperation due to redislocation of SI joint. In the series by Calafi et al [10], the radiological follow up all patients demonstrated radiographic healing. Pelvic malunion occurred in 5 patients (5%) who demonstrated loss of the initial fracture reduction and pelvic symmetry on the 6-weeks radiographs. All 5 of these patients were

asymptomatic and did not require pelvic deformity correction surgery or external corrective devices.

Our radiological results are similar to Khaled et al [9] and Starr et al [13] regarding quality of reduction and union. The nonunion case in our work was in patient with CRF. However, our results were better than Shui et al [16] and Calafi et al [10]. Higher rates of Tile C injuries may have decreased the radiological score of them

In Lindahl [19] study on 39 patients with fracture pelvis and acetabulum (Surgery was delayed more than 21 days after trauma), 37 of them had pelvic fractures. Overall radiological results were excellent or good in 34 out of 39 patients (87%). In 5 patients the residual vertical or AP displacement in the posterior or anterior injury to the pelvic ring was >10 mm. the functional results were also sum of excellent and good in the same 34 out of 39 patients (87%). three out of 5 patients with fair or poor functional outcome had a permanent lumbosacral plexus injury with motor deficiencies. This result is in accordance with our results regarding association of Majeed [7] scoring system and Tornetta and Matta [8] radiological score. Also, the results of Lindahl [19] indicates that delayed surgery doesn't affect only radiological outcome but also may predispose to neurological injury.

Limitation of the study: The sample size of this study was small, the follow up period need to extended and different techniques were used.

CONCLUSION

Good and precise preoperative evaluation (Clinical and radiological) is crucial in deciding method of fixation to avoid iatrogenic nerve injury. Early and anatomic reduction and fixation of crescent fracture dislocation is needed to improve results of management of this injury. The percutaneous surgical procedure could simplify the treatment of pelvic ring fractures and avoid massive blood loss and incision complications.

CONFLICT OF INTEREST: Nothing to declare.

FINANCIAL DISCLOSURE: Nothing to declare.

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