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Treatment of Fracture Sacrum by Open Reduction Versus Closed Reduction : A Comparative Study

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Abstract

Early surgical fixation of sacral fractures is the treatment of choice due to several advantages, such as early ambulation, and reduced morbidity as well as mortality. However, the optimal method of fixation, especially in unstable fractures, remains controversial. Open reduction internal fixation (ORIF) requires extensive exposure with a high risk of several Intraoperative and postoperative complications, including massive hemorrhage, deep venous thrombosis, neurovascular injuries, heterotopic ossification (HO), and infection. Currently, percutaneous screw fixation of sacral fractures is increasingly used worldwide with promising outcomes. The advantages for percutaneous screw fixation of sacral fractures include less soft tissue injury, less blood loss, and a lower rate of infection. Furthermore, early weight-bearing ambulation will be possible with percutaneous screw fixation. This is a major advantage of this method, compared to open methods and plate fixation, which usually need a prolonged duration of limited weight bearing. The aim of this work was to be to compare the clinical, radiologic, functional outcomes and complications of open reduction and closed reduction for treating sacral fractures. This prospective comparative study was carried out on 30 patients with sacral fractures in Helwan university hospital and El-Helmia Military Hospital during a period of 18 months. They were divided into 2 equal groups: Group A: 15 patients were treated by closed reduction and percutaneous iliosacral screw fixation (CRIF). Group B: 15 patients were treated by open reduction and internal fixation (ORIF). Regarding outcome, there is statistically non-significant difference between the studied groups. About 53% within closed reduction group versus 47% within open reduction group had excellent outcome. About 33% within closed reduction group versus 27% within open reduction group had good outcome. Early stabilization of the vertically unstable pelvic fracture is valuable in terms of reducing morbidity and improving long-term functional outcome. Closed reduction and percutaneous iliosacral screws are very useful for dealing with the posterior lesion with minimum morbidity. However, our results suggest that for optimum anatomic results, rigid internal fixation of the anterior lesion is required.

Keywords: Orthopaedic Surgery, Sacral Fracture, Open Reduction technique, Closed Reduction technique

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1. Introduction

Sacral fractures are a heterogeneous group of fractures occurring in young people following road accidents and falls from height or in the elderly with osteoporosis following trivial trauma. The incidence of non-osteoporotic sacral fractures has been reported as 2.1 cases per 100,000 people, while osteoporotic fractures have been reported to have an incidence of 1–5% in elderly patients at risk [1]. Sacral fracture diagnosis is often troublesome, with a rate of missed or delayed diagnosis ranging from 25% to 70%. Overall, the diagnosis should be made by assessing specific features during the clinical presentation particularly after high-energy trauma [2]. Following the Advanced Trauma Life Support (ATLS) guidelines, every patient with high-energy trauma should undergo anteroposterior radiography of the pelvis. However, this imaging modality may not adequately show sacral fractures, with an overall detection rate as low as 30%. The first line of investigation in patients presenting with fractures of the anterior elements of the pelvic ring is a CT scan, which is able to detect sacral fractures with a reported sensitivity of 68-88% [3]. MRI has

the highest sensitivity (98%). It is able to diagnose occult fractures missed by CT because of intact cortices. MRI could help in differential diagnosis by detecting the bone edema, which is sign of infection, or tumor, which must be excluded. When a stress fracture is suspected, MRI is the indicated exam, followed by a bone scan and CT scan respectively [4]. Surgical indications for sacral fractures include unstable fractures, neurological deficit, and severe axial or sagittal spinal misalignment. Surgical techniques can be split into two main groups: posterior pelvic fixation techniques and lumbopelvic fixation techniques. If the fracture is associated with pelvic ring injury, anterior pelvic fixation techniques can be performed. Posterior pelvic fixation techniques connect the ilium to the sacrum. They can be performed either percutaneously (closed reduction) or in an open manner (open reduction) [5]. The aim of this work was to compare the clinical, radiologic, functional outcomes and complications of open reduction and closed reduction for treating sacral fractures.

2. Materials and Methods

This prospective comparative study was carried out on 30 patients with sacral fractures in Helwan university hospital and El-Helmia Military Hospital during a period of 18 months. The Ethics committee of the Faculty of Medicine, Helwan University, Egypt, approved the study. Written informed consent was obtained from the guardians of all patients included in the study. Patients with open pelvic fractures, sacral dysmorphism and grossly displaced acetabular fractures patients were excluded from our study. Cases were divided into 2 groups, Group A: 15 patients were treated by closed reduction and percutaneous iliosacral screw or trans-iliac bridging system (CRIF). Group B: 15 patients were treated by open reduction and internal fixation by plated or pedicle screws connected with bars in cases of spinopelvic dissociation (ORIF). All the studied patients were subjected to the following: 1- History taking, 2- Clinical examination, 3-Radiological assessment with pelvis X-rays (AP and lateral views), and computed tomography (CT) (with 3-mm sections through the sacroil-iac joint). 3- surgical treatment Group A: treated by closed reduction and percutaneous iliosacral screw or trans iliac bridging system (CRIF) and Group B: were treated by open reduction and internal fixation by plated or pedicle screws connected with bars in cases of spinopelvic dissociation (ORIF)

2.1. Statistical analysis

Data analysis was performed using the software SPSS (Statistical Package for the Social Sciences) version 26. Quantitative variables were described using their means and standard deviations. Categorical variables were described using their absolute frequencies and were compared using chi square test, Fisher exact test and Monte Carlo tests when appropriate. For ordinal binary data, chi square for trend test was used. Kolmogorov-Smirnov (distribution-type) and Levene (homogeneity of variances) tests were used to verify assumptions for use in parametric tests. To compare quantitative data between two groups, independent sample t test (for normally distributed data) and Mann Whitney test (for not normally distributed data) were used. The level statistical significance was set at $P<0.05$. Highly significant difference was present if $p\leq0.001$.

3. Results and discussion

There was statistically non-significant difference between the studied groups regarding gender or age. Male represented 60% and 73.3% of those within closed and open reduction groups respectively - Table 1. There was statistically non-significant difference between the studied groups regarding AO, tile classifications. 61B2 was the cause of fracture in 40% and 13.3% of those within closed and open reduction groups respectively (Table 2). There is statistically non-significant difference between the studied groups regarding operative time and time till operation - Table 3. There is statistically non-significant difference between the studied groups regarding post-fix, pin tract, or other events. One patient within closed reduction group had DVT and infection while one patient within open reduction gad abdominal pain. Pin tract was reported in 6.7% within closed reduction group while no one had pin tract in open reduction group. Lateral cutaneous nerve showed no injury in 60% and 93.3% within closed and open reduction groups respectively with statistically significant difference between groups - Table 4. There is statistically significant difference between the studied groups regarding sexual activity till removal. Excellent score was reported in 6.7% within closed reduction group versus 26.7% open reduction group. There is statistically non-significant difference between the studied groups regarding sitting, standing ability or walking ability. Excellent walking ability occurred in one patient within each group. Excellent standing ability occurred in 20% and 33.3% within closed and open reduction groups respectively. There is statistically non-significant difference between the studied groups regarding duration till removal which was non-significantly longer in open reduction group - Table 5. There is statistically significant difference between the studied groups regarding outcome. Excellent score occurred in 40% and 53.3% within closed and open reduction groups respectively -Table 6. Vertically unstable fractures of the pelvis account for about 6% of all fractures and are commonly associated with sacral fractures, but it is well established that extensive disruption of the pelvis is associated with high rates of mortality and late morbidity [6]. According to Tile's classification, the characteristic of completely unstable pelvic ring injury is complete disruption of the posterior sacroiliac complex associated with an anterior pelvic ring injury. The posterior lesion may be a displaced fracture of the sacrum or ilium, a dislocation through the sacroiliac joint, or a combination of fracture and dislocation injuries. This lesion renders the pelvis unstable in all planes. Vertical instability refers to disruption of the anterior and posterior pelvic ring allowing potential displacement posteriorly, superiorly, and in the sagittal plane rotation (flexion), in addition to rotation in the horizontal plane (internal or external rotation) [7]. Efforts have been made to improve the results of treatment by a more interventional approach. There is increased interest in the use of internal fixation of the posterior disruption. There is a variety of methods available, including iliosacral screws, transsacral-bridging system [8]. Routt et al. (1995) have popularized Iliosacral screw fixation. These screws may be used for both sacroiliac joint dislocations and sacral

fractures and can be placed percutaneously if a satisfactory closed reduction can be obtained [9]. More direct methods of reduction and fixation include techniques of anterior and posterior plating. Anterior plate fixation of a sacroiliac dislocation is a useful technique. Simultaneous exposure of the anterior lesion is possible and the quality of reduction is therefore easier to assess. However, access to the sacral side is limited and injury to the L5 nerve root is a definite risk. Anterior plating is not feasible for sacral fractures because the medial access is too limited. Posterior approaches have been advocated, particularly for sacral fractures [10]. Iliosacral screw fixation is a well-recognized technique for treating the posterior lesion. Iliosacral screws may be used for both sacral fractures and sacroiliac joint dislocations. Fixation has most commonly been carried out using an open posterior approach. Some authors have noted a high complication rate in association with posterior pelvic wounds. The major disadvantage of the posterior approach is the risk of impaired wound healing and subsequent infection [11]. The use of percutaneous placement has been described. This method has particular advantages in the multiply traumatized patient and in patients with hemodynamic instability where it is desired to minimize blood loss. However, an adequate closed reduction must be obtained prior to screw placement [12]. The benefits of fixation remain to be clearly established and whether posterior pelvic ring injuries are best treated using open reduction and internal fixation (ORIF) or closed reduction and percutaneous iliosacral screw (CRIF) remains a controversial topic [13]. Open reduction and internal fixation (ORIF) is considered the treatment of choice in vertically unstable longitudinal fractures of the posterior pelvic ring. Exsanguination, sepsis, and multiorgan failure, as well as disabling chronic pain and functional deficits, can thus be partially avoided. Furthermore, malunion and nonunion in up to 54% of cases have been described with conservative treatment. Drawbacks to ORIF are considerable tissue traumatization, substantial intraoperative blood loss, and up to 25% infectious complications [7]. Closed reduction and percutaneous iliosacral screw (CRIF) combines the advantages of ORIF with those of conservative therapy by taking a minimally invasive approach to screw insertion. It is a valid alternative to ORIF in these fractures; provided that satisfactory reduction is achieved can [14]. The purpose of the present study was to compare the clinical, radiologic, functional outcomes and complications of open reduction and closed reduction for treating sacral fractures. This prospective comparative study was carried out on 30 patients with sacral fractures in Helwan university hospital and El-Helmia Military Hospital during a period between october 2020 and october 2022. They were divided into 2 equal groups: Group A: 15 patients were treated by closed reduction and percutaneous iliosacral screw fixation (CRIF). Group B: 15 patients were treated by open reduction and internal fixation (ORIF). There is no significant statistical differences between the two groups regarding gender or age. Male represented 60% and 73.3% of those within closed and open reduction groups respectively. In comparison to other studies Rodrigeuss et al.,(2017) reported similar results to our studies and there was no significant statistical difference between the two comparing groups of his studies. Male represented 65% and 74.5 %of those within closed and open group respectively [2]. Ruatti et al. (2013), reported also equal results with no significant statistical difference although this has more restricted age group in his study (15-55 years old) and also no significant differences was present. Therefore, our study was comparable to other relative studies as regarding demographic data [15]. In our study, the functional outcome according to Majeed score was superior in closed reduction (group A) to open reduction (group B) but with no statistical difference. There is no significant difference between the studied groups regarding sitting, standing ability or walking ability. Excellent walking ability occurred in one patient in each group. Excellent standing ability occurred in 3 and 5 patients in closed and open group respectively at the follow up of 18 month. When compared to other studies, Meinberg et al, (2018) group A was superior to group B with no significant statistical difference. Although better reduction in group B with good early range of motion both groups had nearly the same ultimate function [16]. In our study there is difference in both operative time and operative delay but not statistically significant. In the beginning of the study closed reduction group(group A) consume less intraoperative time than open reduction (group B) nearly by 20-30 minutes but near the end of the study by improving the surgical technique the difference between the two groups improved. In comparison for other studies Salama et al., (2011) reported that the results of group A is higher than group B as regarding the intraoperative time and delay but the difference between them is statistically nonsignificant [13]. Stover MD et al., (2012) reported that the difference between the intraoperative times for both groups is dependent on many factors the surgeon skills, operative room facilities, imaging facilities, general condition of the patient and energy of trauma [13]. In our study, we evaluated and compared the amount of intraoperative blood loss of post pelvic ring injuries managed by either CRIF or ORIF. The average of intraoperative blood loss in the CRIF was 150-250 cc ,with average of blood transfusion of one unit(500 cc) compared to blood loss 750-850 cc in the ORIF at the beginning of the study and that amount is improved at the the last 6 cases to 600-700 cc with average transfer of two units(1000 cc). Elzohairy and Salama (2017) the average intraoperative blood loss in the ORIF group was 500 cc with average blood transfusion of two units (1000 cc) compared to blood loss 150 cc in the CRIF group, with average blood transfusion of one unit (500 cc), with statistically significant difference between the studied groups. Therefore, our study is less than this study as regarding the intraoperative blood loss [17]. In our study, two patients within closed reduction group had broken operative guide. Elzohairy and Salama (2017) reported also two guide wires were broken in the closed reduction group [17]. Ruatti et al. (2013) reported 3 guide wires were broken in closed reduction group [15]. In our study there were 6 cases of post-operative radiculopathy in the CRIF group one of them is bilateral and 5 are unilateral, 5 cases improved on removal and only one case not improved.In the ORIF group only one case of radiculopathy is present. Elzohairy and Salama (2017) reported there were no neurological complications observed in the ORIF group, but one radiculopathy (L5 root palsy) occurred in the CRIF group [17]. Farouk (2007) reported two cases of radiculopathy in the CRIF group with no neurological injuries in the ORIF group [10].

Table 1. Comparison between the studied groups regarding demographic data

Parameter	Closed reduction group	Open reduction group	χ^2	p
	N=15(%)	N=15(%)		
Gender: Female Male	6 (40%) 9 (60%)	4 (26.7%) 11 (73.3%)	0.6	0.439
	Mean ± SD	**Mean ± SD**	**t**	**p**
Age	33.67 ± 9.14	35.4 ± 7.7	-0.562	0.579

χ2 Chi square test, t independent sample t test

Table 2. Comparison between the studied groups regarding fracture classification

Parameter	Closed reduction group	Open reduction group	χ2	p
	N=15(%)	N=15(%)		
AO classification: 61B2 61B3 61C1 61C2 61C3	6 (40%) 1 (6.7%) 5 (33.3%) 2 (13.3%) 1 (6.7%)	2 (13.3%) 6 (40%) 7 (46.7%) 0 (0%) 0 (0%)	0.029	0.864
Tile classification: B2 B3 C1 C2 C3	6 (40%) 1 (6.7%) 5 (33.3%) 2 (13.3%) 1 (6.7%)	2 (13.3%) 6 (40%) 7 (46.7%) 0 (0%) 0 (0%)	0.029	0.864

χ2 Chi square for trend test

Table 3. Comparison between the studied groups regarding operative data

Parameter	Closed reduction group	Open reduction group	t	p
	Mean ± SD	**Mean ± SD**)		
Operative time (min)	40.27 ± 9.7	42.13 ± 5.14	0.185	0.855
	Median(IQR)	**Median(IQR)**	**Z**	**p**
Time to operation (day)	6 (2 – 14)	10 (3 – 16)	-0.502	0.616

t independent sample t test Z Mann Whitney test IQR interquartile range

Table 4. Comparison between the studied groups regarding postoperative events

Parameter	Closed reduction group	Open reduction group	χ^2	p
	N=15(%)	**N=15(%)**		
Post-fix:				
No	2 (13.3%)	1 (6.7%)		
Ilio-ilial	1 (6.7%)	3 (20%)		
Ilio-ilial, plate	1 (6.7%)	1 (6.7%)		
Plates	0 (0%)	1 (6.7%)		
Sis	6 (40%)	7 (46.7%)	0.917	0.989
Spinopelvic	4 (26.7%)	2 (13.3%)		
Spinopelvic, plate	1 (6.7%)	0 (0%)		
LCNT:				
Bilateral, improved after removal	1 (6.7%)	0 (0%)		
Negative	9 (60%)	14 (93.3%)		
Unilateral, improved after removal	4 (26.7%)	1 (6.7%)	MC	<0.001**
Unilateral, still after removal	1 (6.7%)	0 (0%)		
Pin tract:				
Negative	14 (93.3%)	15 (100%)	Fisher	>0.999
Positive	2 (13.3%)	0 (0%)		
Others:				
No	14(93.3%)	14(93.3%)		
Abdominal pain	0(0%)	1(6.7%)		
DVT	1(6.7%)	0(0%)	MC	>0.999
Infection	2 (13.3%)	3 (20.1%)		

χ^2 Chi square test, MC Monte Carlo test, **p≤0.001 is statistically highly significant, LCNT lateral cutaneous nerve trauma

Table 5. Comparison between the studied groups regarding outcome till end of study

Parameter	Closed reduction group	Open reduction group	χ^2	p
	N=15(%)	N=15(%)		
Sitting: Good Excellent	 15 (100%) 0 (0%)	 14 (93.3%) 1 (6.7%)	Fisher	>0.999
Standing ability: Fair Good Excellent	 2 (13.3%) 10 (66.7%) 3 (20%)	 2 (13.3%) 8 (53.3%) 5 (33.3%)	0.377	0.561
Walking ability: Fair Good Excellent	 6 (40%) 8 (53.3%) 1 (6.7%)	 5 (33.3%) 9 (60%) 1 (6.7%)	0.094	0.759
Sexual ability: No Fair Good Excellent	 3 (20%) 4 (26.7%) 7 (46.7%) 1 (6.7%)	 0 (0%) 3 (20%) 8 (53.3%) 4 (26.7%)	4.421	0.036*
Duration to removal	**Mean ± SD**	**Mean ± SD)**	-0.274	0.786
	4.67 ± 1.4	4.8 ± 1.26		

Chi square for trend test *p<0.05 is statistically significant

Table 6. Comparison between the studied groups regarding outcome

Parameter	Closed reduction group	Open reduction group	χ^2	p
	N=15(%)	N=15(%)		
Outcome Poor Good Excellent	 1 (13.3%) 8 (53.3%) 6 (40%)	 1 (6.7%) 6 (40%) 8 (53.3%)	3.857	0.049*

χ2 Chi square for trend test , *p<0.05 is statistically significant

Infection, in our study one patient within closed reduction group had superficial infection. Two patients within open reduction group had superficial infection and one had deep infection. Farouk (2007) found infection once after percutaneous iliosacral screw fixation in an immune compromised multiply injured patient with intra-peritoneal haemorrhage and traumatic intrauterine foetal death. He reported also one patient within the ORIF group had deep infection [10]. Elzohairy and Salama (2017) found that in the ORIF group, three patients had superficial wound infection and one patient had deep infection while in the CRIF group, we noted only one case of deep infection [17].
In our study from the starting of the study we insisted on strict anticoagulant regimen for both groups. One case within the CRIF group had DVT .No cases in the ORIF group were found with DVT. Elzohairy and Salama (2017) reported three cases of DVT within the the CRIF and one case in the Orif group [17]. Farouk (2007) reported one case in the CRIF group and one case in the ORIF group [10]. Regarding outcome in our study, there is statistically non-significant difference between the studied groups. About 53% within closed reduction group versus 47% within open reduction group had excellent outcome. About 33% within closed reduction group versus 27% within open reduction group had good outcome. Elzohairy and Salama (2017) found that in the ORIF group, 28 patients obtained good or excellent results (20 excellent and 8 good), five fair and two poor. In the CRIF group, 30 patients obtained good or excellent results (25 excellent and 5 good), four fair and one poor, with no significant difference between the studied groups [17]. Farouk (2007) found that reduction of the posterior injury was excellent in twenty-two patients (61%), good in ten (28%) and fair in four (11%) at the initial operative procedure [10]. Schweritz et al. (2013) reported the results of percutaneous iliosacral screw insertion in 71 patients with unstable pelvic fractures. After 31 months of follow-up, 61 patients (86%) could return to their preoperative activities and work. Furthermore, they reported excellent results in 66 patients regarding their last follow-up. However, postoperative neurologic deficit and sacroiliac osteoarthritis occurred in 2 (2.8%) and 15 (21.1%) patients, respectively, regarding long-term follow-up [18]. Ruatti et al. (2013) found that good quality percutaneous reduction is usually sufficient to achieve decompression of the sacral nerve roots [15]. In the present study, we faced some common problems and limitations including the analysis of surgical procedures that is hampered by the use of small subject groups, infrequent use of a control group, unmatched selection of patients of varying ages and a varying severity of the injury process.

4. Conclusions

Early stabilization of the vertically unstable pelvic fracture is valuable in terms of reducing morbidity and improving long-term functional outcome. Closed reduction and percutaneous iliosacral screws are very useful for dealing with the posterior lesion with minimum morbidity. However, our results suggest that for optimum anatomic results, rigid internal fixation of the anterior lesion is required. The technical decision is variable according to time of surgery or referral, fracture types, patient general condition, skin condition, presence of ipsilateral fractures of the acetabulum and feasibility of the closed reduction.

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Conflict of Interest

Nil.

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