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Efficacy of Surgical Treatment of Unstable Sacral Fractures

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ABSTRACT

Background: Complications of sacral fractures include hemorrhage, shock and neurological complications, sensory, motor. **Objective:** To evaluate the clinical and radiographical results of surgical treatment of unstable sacral fractures. **Patients and Methods:** This study was carried out as an interventional prospective study on 24 patients with unstable sacral fracture. Clinical evaluation was assessed, and Radiological assessment was done.

Results: 17 patients underwent iliosacral screw, 4 spino pelvic, 2 patients underwent plate, and one plate with spinopelvic. Satisfactory outcome group significantly younger in age and shorter in operation days. In this study 7 cases of infection 6 superficial 1 deep. In this study, 1 pt had deep venous thrombosis, 3 chest infection. There were 2 cases with postoperative neurological deficits improved within 4 months and one case didn't improve during follow up. Post-operatively all patients were clinically assessed according to Majeed score. Excellent cases were 10 (41.7%), good results were 12(50%) and fair were 2 (8.3%). **Conclusion:** Patients were found to have a good outcome; therefore, surgical treatment is effective in unstable sacral fractures. Iliosacral screw fixation is indicated in minimally displaced fractures, usually performed percutaneously, consequently, blood loss is minimal. Sacral fractures are rare and detection of these potentially complicating fractures is very important.

Keywords: Clinical, Radiographical, Surgical treatment, Sacral fractures.

INTRODUCTION

The sacrum is composed of five vertebral segments referred to as S1 to S5. These vertebrae are fused, making the sacrum a solitary block of bone, although, anywhere from 4 to 30% of people can have variations in vertebral segmentation at the lumbosacral junction with segmentation anomalies ranging from the complete fusion of L5-S1 to segmentation of S1 resulting in six lumbar-type vertebrae [(1)].

Sacral fractures rarely occur in isolation, only 5% isolated and 45% with pelvic ring injuries, 25% associated with neurologic injury, frequently missed in 75% in neurologically intact patients, and 50% in patients with the neurological deficit [(2)].

Sacral stability is mainly dependent on the strong ligamentous structures of the pelvic ring, The soft tissue around the sacrum is relatively thin, consisting of the multifidus muscle and the lumbosacral fascia, making this region particularly susceptible to infection, skin breakdown, and hardware related complications [(3)].

Complications of sacral fractures include hemorrhage, shock and neurological complications, sensory, motor [(4)].

The Denis classification for sacral fractures was first described in 1988 and has become the most used classification system for sacral fractures. The Denis classification divides the sacrum into three zones: Zone 1 is lateral to the neuroforamina, zone 2 is through the neuroforamina, and zone 3 is medial to the neuroforamina. Fractures are classified based on the highest zone of involvement. The Denis classification mainly has utility in predicting risk and type of neurologic injury. Zone 1 injuries carry the lowest risk of neurologic injury (<10%) with the most common neurologic deficit being L5 radiculopathy. Zone 2 injuries carry an intermediate (20–30%) risk of neurologic injury. Zone 3 injuries carry the highest (>50%) risk for neurologic injury with the most common neurologic deficit being cauda equina syndrome [(5)].

Plain x-ray is done first AP, lateral, inlet, and outlet views. CT has become the mainstay for diagnosing sacral fractures due to the low sensitivity of radiographs, Noncontract CT imaging in the axial, coronal, and sagittal planes is generally adequate for diagnosing sacral fractures, For complex sacral fractures or sacral fractures that are part of a pelvic ring injury pattern, additional three dimensional reformatted images are often helpful for surgeons to conceptualize fracture patterns and morphology for preoperative planning. Sacral morphology can preclude safe placement of transacral screws, particularly at the S1 level and preoperative CT can be assessed for sacral dysmorphism and adequate osseous pathway for sacral screw placement [(6)].

The goals of surgical treatment of unstable sacral fractures are to restore spine and pelvis stability and to relieve nerve root compression both percutaneous and open techniques for sacral fracture fixation have been described. Most unstable sacral fractures are amenable to percutaneous fixation, with sacroiliac or transacral screws being the most common method of stabilization [(7)].

The study aimed to evaluate the clinical and radiographical results of surgical treatment of unstable sacral fractures.

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PATIENTS AND METHODS

During the period from June 2017 to April 2019, this study was carried out as an interventional prospective study on 24 patients with unstable sacral fracture. 17 of patients underwent iliosacral screws, 4 of patients underwent spinopelvic fixation,2 patients underwent plate and one patient underwent both lumbopelvic fixation and plate. The study was conducted in the Orthopedic surgery department, Zagazig University hospital, and aimed at assessment of the outcomes of the treatment of unstable sacral fractures with follow-up at least 6 months.

Study Population: The included study population were patients with unstable sacral fractures who were admitted to the Orthopedic Department.

Inclusion criteria: According to the protocol of the study.

In this study sacral fractures were decided when the patient fulfilled the criteria:

- Unstable sacral fractures.
- Medically fit.

Exclusion criteria: According to the protocol of the study.

- Open fractures.
- Malignancy.
- Infection.

Methods"

This protocol for Management of unstable sacral fractures consisted of preoperative, intra-operative, and post-operative stages.

Pre-operative Stage:

Preoperative evaluation of all patients included history with stress on the mode of trauma.

All patients were assessed and prepared using the following protocol, which includes:

Clinical evaluation (history, general examination, and local examination), radiological evaluation, Patient counseling, preoperative preparation of the patient.

Clinical evaluation:

Each patient in this study was carefully assessed clinically by taking a detailed history and performing an examination. Preoperative evaluation of all patients included history, clinical examination, radiographs, and routine preoperative labs.

I-History taking includes:

1- Personal data:

- Name.
- Age.
- Sex.
- Occupation.

2 -The mechanism of trauma: MVA or Fall from a height.

3- Date of trauma.

II- Clinical examination:

- General examination.
- Local examination: bruises, scars, wounds, sinuses.
- Pain: site, character, radiation.
- Peripheral pulsations.
- Neurological injury.
- Associated injuries: other factures, urological injuries. Deformity, limb length discrepancy.

During physical examination:

- 5 patients had Hypovolemic shock upon admission, and they were given a blood transfusion, (4 of them had associated fractures and abdominal collection went to exploration).
- 3 patients showed skin contusions upon inspection.
- Associated injuries were recorded and were seen in 13 patients include fracture maxilla, femur, calcaneus, tibia, both bone forearm, neck femur, and pelvis**.**
- Full neurological evaluation: A clinical neurologic examination was performed in patients able to cooperate. Loss of muscle strength was assessed manually in five key movements with corresponding segments, according to the classification by American Spinal Injury Association (ASIA), Sensory examination of the lower extremities was done with pinprick and light touch at key points, and affected dermatomes registered according to American Spinal Injury Association (ASIA).

III- Radiological assessment:

The preoperative radiological evaluation aimed to: Determine the fracture type, Understanding the fracture pattern, Detecting associated fractures or dislocations, and bone stock of the fragments. The radiological evaluation consisted mainly of:

- X-ray: anteroposterior, inlet, outlet views.
- CT: sagittal, axial, coronal, 3D.

Patients were diagnosed and classified according to Denis and Isler's classifications.

Post-operative radiographs:

Plain radiographs were obtained postoperatively. A pelvic CT scan was performed in selected cases postoperatively (cases associated with post-operative neurological deficit and to confirm screw position).

Ethical Consideration:

An approval of the study was obtained from Zagazig University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation.

Statistical analysis

A collected throughout history, basic clinical examination, laboratory investigations, and outcome measures coded, entered, and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software

for analysis. According to the type of data qualitative represent as number and percentage, the quantitative continuous group represented by mean ± SD, the following tests were used to test differences for significance; difference, and association of qualitative variable by Chi-square test (X^2). Differences between quantitative independent groups by t-test,. P-value was set at <0.05 for significant results.

RESULTS

Age was distributed as **34.2±13.49** with a minimum 18 and maximum 51 **(Table 1)**.

Sex was distributed as males were 20 (83.3%) and females were 4 (16.7%) **(Table 2)**.

The reason for trauma was distributed as FFH were 6 (25%) and RTA were 18 (75%), Surgical was distributed as a plate was 2 (8.3%), lumbopelvic were 4 (16.7%), Iliosacral screws were 1 (1%). Denis Classification was distributed as I were 9 (37.5%), II was 12 (50%), III was 3 (12.5%) **(Table 3)**.

Ten patients have excellent Majeed (41.7%) of a total of 24 pt. Twelve patients have good Majeed (50 %) of a total of 24 pt. Two patients have fair Majeed (8.3 %) of the total 24 pt **(Table 4)**. The outcome was distributed as 91.7% were satisfactory **(Table 5)**. Satisfactory outcome group significantly younger in age and shorter in operation days **(Table 6)**.

Table (1): Age distribution among the studied group

	Age
Mean± SD	34.2±13.49
Median (Range)	30.0 (18-51)

Table (2): Sex distributions among the studied group

		N	%
Sex	**Male**	**20**	**83.3**
	Female	**4**	**16.7**
	Total	**24**	**100.0**

Table (3): Clinical Characters of the studied group

		N	%
Reason of trauma	FFH	6	25.0
	RTA	18	75.0
Surgical	plate	2	8.3
	lumbopelvic	4	16.7
	Iliosacral screws	17	74
	Plate and lumbopelvic	1	1
Denis Classification	I	9	37.5
	II	12	50.0
	III	3	12.5
	Total	24	100.0

Table (4): Functional outcome according to the Majeed score:

	Excellent	Good	Fair
No of patients	**10(41.7%)**	**12(50%)**	**2(8.3%)**

Table (5): Outcome distribution among the studied group

		N	%
Outcome	Not	2	8.3
	Satisfactory	22	91.7
	Total	24	100.0

Table (6): Outcome:

			OUTCOME		t- Mann Whitney/ X^2	P-value
			Unsatisfactory	**Satisfactory**		
Age	**Mean ± SD**		50.5±0.7	30.54±9.81	-6.45	0.00**
Operation day	**Mean ± SD**		36.0±5.65	7.13±3.8	-8.21	0.00**
Sex	**Male**	**N**	1	19	1.74	0.18
		%	50.0%	86.4%		
	Female	**N**	1	3		
		%	50.0%	13.6%		
Reason of trauma	**FFH**	**N**	1	5	0.72	0.39
		%	50.0%	22.7%		
	RTA	**N**	1	17		
		%	50.0%	77.3%		
Surgical	**Spinopelvic**	**N**	0	5	0.43	0.5
		%	15.0%	18.2%		
	Iliosacral Screw	**N**	2	15		
		%	75.0%	71.8%		
	plate	**N**	0	3		
		%	10.0%	11.2%		
Denis Classification	**I**	**N**	0	9	3.27	0.19
		%	0.0%	40.9%		
	II	**N**	1	11		
		%	50.0%	50.0%		
	III	**N**	1	2		
		%	50.0%	9.1%		
Total		**N**	2	22		
		%	100.0%	100.0%		

DISCUSSION

In this study 17 patients underwent iliosacral screw,4 spino pelvic, 2 patients underwent plate and one plate with spinopelvic while

Mirzashahi *et al.* [8] Fourteen patients (51.9%) underwent percutaneous iliosacral screw fixation and thirteen patients (48.1%) underwent spinopelvic fixation

Osterhhof [9] proved that percutaneous iliosacral screw fixation is a rapid and definitive treatment for posterior pelvic ring injuries with a low risk of secondary bleeding during posterior pelvic stabilization. The technique using standard C-arm fluoroscopy was also found to be safe for screws placed in S2 with the agreement of our study, **Nork *et al.*** [10] found bilateral percutaneous iliosacral screw fixation to be safe and effective in treating a minimally displaced sacral-U fracture.

Mirzashahi *et al.* [8] reported 10 cases with pelvic fractures, together with sacral fractures and spinopelvic instability that underwent spinopelvic fixation. They showed that preoperative VAS and Oswestry index was changed dramatically and concluded that aggressive stabilization and fixation must be done, as soon as possible and without any delay, in patients who suffered from spinopelvic instability.

Mirzashahi *et al.* [8] reported four cases with U-shaped sacral fractures that underwent early surgical treatment. Due to spinopelvic dissociation and neurologic deficits in their series, laminectomy and spinopelvic fixation were done. Also, they reported that no complication was encountered because of fixation. They also reported that this kind of fixation allows early mobilization of polytraumatized patients.

In this study, the satisfactory outcome group significantly younger in age and shorter in operation days similar to **Routt *et al.*** [11], Showed that delays of surgery of 5 days or longer were related to poorer closed reduction rates and **Denis *et al.*** [12], Reported that delays longer than 2 weeks had poorer outcomes in neurologically consistent patients (4,12). Late surgery was performed in 7 of our cases (70%) and this affected the success of the reduction negatively. The importance of early surgery must be stressed in preventing spinopelvic imbalance.

In this study, 7 cases of infection 6 superficial 1 deep **but Routt *et al.*** [11] proved that there were no posterior pelvic infections. Minimal blood loss was associated with this technique. Complications occurred due to inadequate imaging, surgeon error, and fixation failure. Fluoroscopic imaging was inadequate due to obesity or abdominal contrast in eighteen patients. Five screws were misplaced due to surgeon error. One misplaced screw produced a transient L5 neuropraxia. Fixation failures related to either delayed union, non-compliance, and a deep anterior pelvic polymicrobial infection secondary to a urethral tear occurred in seven patients. There was one case sacral nonunion that required debridement, bone grafting, and repeat fixation before healing.

In this study, 1 pt had deep venous thrombosis,3 chest infection while **Kamerkar *et al.*** [13] proved that five patients (13 percent) suffered a pulmonary embolus in the early postoperative period, one of which was fatal, hospital mortality of 2.6 percent. Screw misplacement occurred in five patients but there were no adverse sequelae. In thirty-four cases with radiographic follow-up, malunion was noted in fifteen cases (44 percent). A lower rate of malunion (36 percent) was noted with internal fixation of the anterior lesion. Of twenty-six patients with long-term follow-up, only four (15 percent) had no pain. Sacroiliac fusion for pain was performed in three patients (11 percent). Twelve patients (46 percent) returned to their pre-injury occupation, six patients (23 percent) changed occupation, and nine patients (30 percent) had not yet returned to work by the last follow-up.

In this study, there were 2 cases with postoperative neurological deficits improved within 4 months and one case didn't improve during follow up while **Taguchi *et al.*** [14] found that, amongst the seven cases with neurological deficits, two cases improved completely and five cases improved partially during follow up.

Bellabarba *et al.* [15] had 22 cases with preoperative neurological deficits but only six of them recovered. They explained this low rate by the presence of nerve root avulsions in most of these cases.

CONCLUSION

Patients were found to have a good outcome, therefore surgical treatment is effective in unstable sacral fractures. Iliosacral screw fixation is indicated in minimally displaced fractures, usually performed percutaneously, consequently, blood loss is minimal. Sacral fractures are rare and detection of these potentially complicating fractures is very important. A high index of suspicion and use of diagnostic modalities, such as X-ray, CT scan, MRI are mandatory to recognize these fractures. In terms of treatment for nondisplaced Denis type 1 and 2, it seems that minimally invasive techniques, like percutaneous iliosacral fixation, are good options and for spinopelvic dissociation, spinopelvic fixation is the treatment of choice, with a reasonable outcome.

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