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Efficacy of Surgical Treatment of Unstable Sacral Fractures

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Abstract

Background: The treatment of sacral fractures is challenging and controversial, operative fixation provides stability, a stable sacral fracture fixation construct reduce pelvic pain, allows the patient to be mobilized to a chair or crutches and protects the local neurovascular structures. The purpose of this study was to achieve stability, early mobilization and relieve nerve compression, this done by iliosacral screw, spinopelvic fixation and plate for patients with unsatable sacral fractures.

Subjects and Methods: This was prospective study includes 24 patients with unstable sacral fracture surgically treated from June 2017 to April 2019 in orthopedic surgery department Zagazig University Hospital, with mean age 34.2 years (range 18-51), full clinical evaluation was taken, full investigations were done and Radiological assessment with minimum follow up: 6 months.

Results: 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%).

Conclusions: Sacral fractures are rare and detection of these potentially complicating fractures is very important.

Keywords: Surgical treatment, Sacral fractures, Iliosacral screw, Spinopelvic fixation.

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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 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 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 commonly 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 an 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)]. This study aimed to achieve stability, early mobilization and relieve nerve compression, this done by iliosacral screw, spinopelvic fixation and plate for patients with unsatable sacral fractures.

SUBJECTS AND METHODS

During the period between June 2017 to April 2019, 24 patients 20 (83.3) males and 4 (16.7) female were presented with unstable sacral fracture. The mean age of the patients was 34.2 years (rang from 18 to 51years). 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. Study was conducted in orthopedic surgery department Zagazig University Hospital with follow up at least 6 months. The study was approved by the institutional ethics

committee and also informed written consent was taken from patients and/or their caregivers. This Work was performed according to the code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria

According to the protocol of the study unstable sacral fractures, medically fit. Exclusion criteria: Open fractures, Malignancy, Infection.

Pre-operative

All patients were assessed and prepared using the following protocol, which includes: Clinical evaluation (history, general examination and local examination), X-ray and CT scan.

The aim of preoperative radiological evaluation was to determine the fracture type, Understanding the fracture pattern, Detecting associated fractures or dislocations and Bone stock of the fragments.

Full investigations were done (liver functions, kidney functions, coagulation profile, blood sugar, ECG). Control of associated comorbidities (diabetes, hypertension, allergy to specific medication). Anesthetist assesses the patient preoperatively to choose the proper type of anesthesia. Two units of blood were grouped and saved for each patient for operation.

Patients were diagnosed and classified according to Denis and Isler. According to denis classification of sacral fractures, there were 9 patients with type 1 fracture (37.5%), 12 with type 2 fracture (50%), 3 with type 3 fracture. According to Isler classification of sacral fractures, there were 14 patients with type 1 fracture (58.5%), 7 with type 2 fracture (29%), 3 with type 3 fracture (12.5%).

The time that elapsed from the date of trauma to the operation ranged from 2 to 10 days with a mean of 5.4 days and SD ± 2.3 days.

Method of fixation for sacral fractures; Percutaneus or open iliosacral screws, Transiliac plating and lumbopelvic fixation.

Iliosacral screw Surgical technique

All patients were operated on supine position with radiolucent table. Pelvis was slightly elevated with folded towel under ipsilateral buttock, kept at edge of table. True lateral view of pelvis, inlet, outlet and anterio-posterior views were ensured and marked on the C- arm. The position of C-arm on the floor in relation to Operation table was also marked which was helpful in easy and quick access to views during surgery. True lateral view was ensured when two sciatic notches overlap with each other and end plates of S1 vertebra were also overlapped. Iliac cortical density (ICD) needed to be well defined for secure entry point for iliosacral screw fixation (Fig.1). True inlet view was obtained when anterior edge of S1 and S2 overlap and vertebral canal was well defined. Similarly, when superior edge of symphysis pubis overlaped S2, true outlet view was confirmed[7].

After draping and part preparation, reduction of sacroiliac joint or sacral fracture was ensured. Upper tibial skeletal traction was used for longitudinal traction. If required, percutaneously applied ball spiked pelvis clamps on iliac blade was used to get reduction. Entry point for sacral screw was confirmed on lateral view. It should be below and behind ICD. A stab incision was made and 2 mm guide wire was gently tapped into iliac blade at entry point so that it didn't get dislodged during subsequent procedure (Fig.2). C-arm was now rotated to obtain Inlet, outlet and AP view and guide wire was advanced further in such a way that, guide wire was superior to S1 foramen in outlet view, below L5-S1 intervertebral disc space in AP view, within S1 body in inlet view. Once positioning of guide wire was ensured in all views and confirmed that it was not extraosseous or into vertebral canal, required length of screw was measured indirectly. Appropriate length 7 mm cannulated cancellous screw (CCS) was passed under C arm guidance after drilling with 4.5 mm cannulated drill (Fig.3, 4). While passing two screws, simultaneous advancing both screws turn by turn was helpful when they were very near to each other. Partially threaded CCS with washer was used for sacroiliac joint disruption and fully threaded CCS for sacral fracture. Similar procedure was repeated for contra lateral side when required[8].

Figure 1. Landmark for insertion of iliosacral screw on the lateral view (ICD).

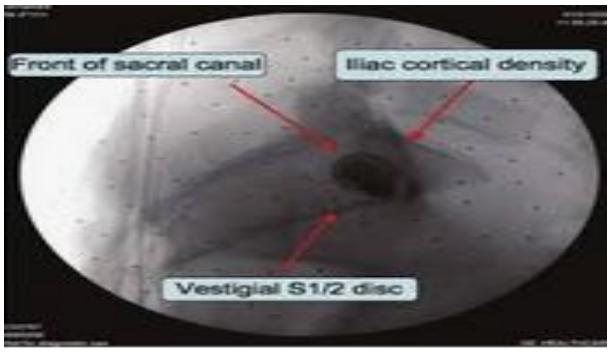

Figure 2. Stab incision

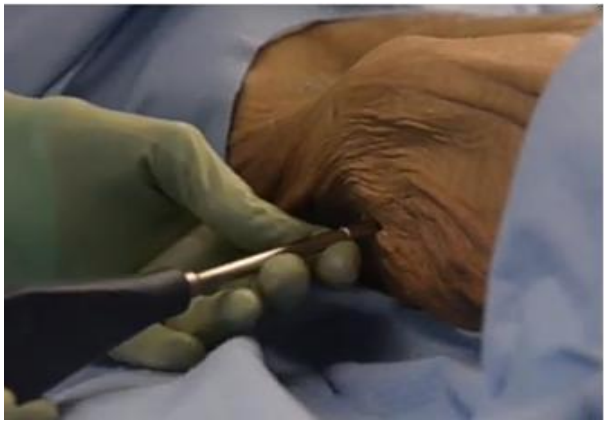

Figure 3. Insertion of CCS screw

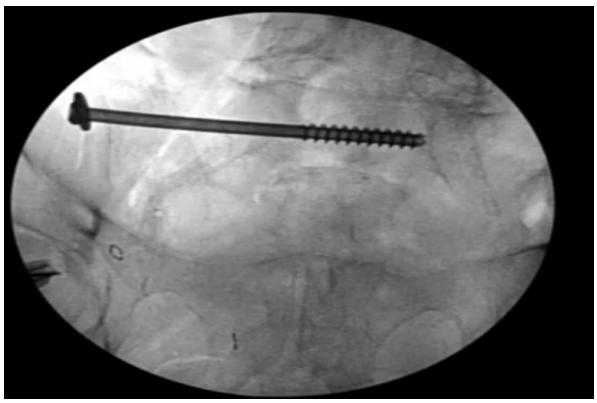

Figure 4. Position of screw

Posterior tension band plate Surgical technique

4.5 narrow precontoured DCP is placed along dorsum of the sacral and through the posterior iliac spines (transiliac plate fixation). Patient is placed in the prone position. Two incisions are made over the PSIS which are perpendicular to the iliac wings. Dissections are carried down to the bony surfaces; (dissection has to be down to bone leaving thick subcutaneous flab). Use the 4.5 drill to make 2-3 drill holes 1 cm lateral to the PSIS. 12 holes DCP 4.5 mm narrow plate is chiseled thru the iliac spine, passed along the dorsum of the sacrum to the opposite PSIS, the plate is fixed to the iliac wings using 4.5 mm cortical screws with four screws inserted into each iliac wing (Fig.5).

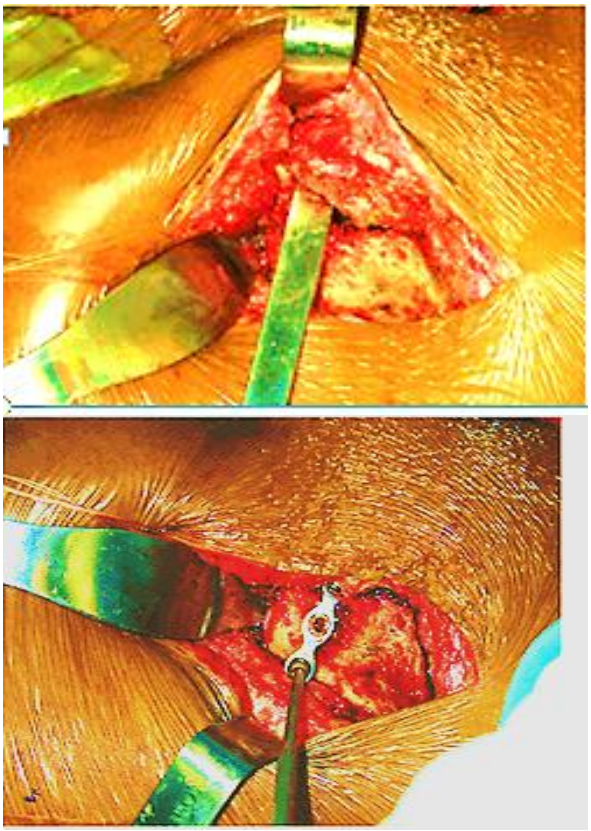

Figure 5. surgical steps of posterior iliosacral tension band platting.

Lumbopelvic fixation Surgical technique

The patients were placed prone. Dissection made by midline incisions. Neural decompression done by removal of comminutions from foramina if present with reduction. Pedicle screws are inserted and connected with the rod. Iliac screws are inserted. Insertion of the connecting rod. Check position of implants by AP, inlet and outlet view Figure 6.

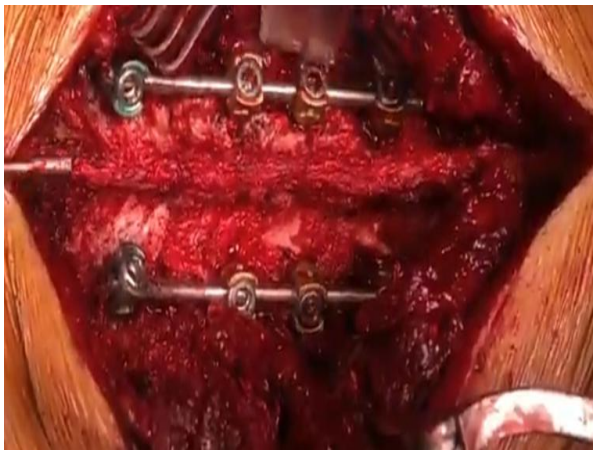

Figure 6. Intraoperative photo.

Follow up

The patients were examined each day during hospitalisation, and every week until 6 weeks after discharge, the patients were seen every one month till 9-12 months. Majeed functional scores and clinical grading was used for functional outcome taking in account of pain (30 points), return to work (20 points) sitting (10 points), sexual activity (4 points) and standing (walking aids; 12 points, gait ; 12 points and walking distance; 12 points). Score >85 was considered excellent, 70 to 84 good, 55 to 69 fair and <55 poor[9].

Post-operative radiographs

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

Complications

Non orthopaedic complications developed in 6 patients: deep vein thrombosis in one patients, chest infection in 3 patients, all complications in these 4 patients resolved with specific appropriate treatments. One patient developed urethral stricture secondary to urethral injury, the patient had anastmotic urethroplasty three months later. One patient had right vas deference cut intra operatively.

RESULTS

Age was distributed as 34.2±13.49 with a minimum 18 and maximum 51. Sex was distributed as males were 20 (83.3%) and females were 4 (16.7%). 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 1).

There were in the study 24 patients classified by ASIA score preoperative as ASIA A0, ASIA B1, ASIA C3, ASIA D5, ASIA E15 patients. postoperative there were improvement as in (table 2).

Ten patients have excellent majeed (41.7%) of total 24 pt. 12 patients have good majeed (50 %) of total 24 pt. 2 patients have fair majeed (8.3 %) of total 24 pt table 3.

Satisfactory outcome group significantly younger in age and shorter in operation days table 4.

Table.1. Demographic data

	Age

Mean± SD		**34.2±13.49**	
Median (Range)		**30.0 (18-51)**	
		N	**%**
Sex	**Male**	**20**	**83.3**
	Female	**4**	**16.7**
Total		**24**	**100.0**
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 2. ASIA score distribution pre and post

		Pre		Post		P
		N	%	N	%	
ASIA	B	1	4.1	0	0.0	**0.02***
	C	3	12.5	1	4.1	
	D	5	20.8	2	8.2	
	E	15	64.6	15	64.6	

Table 3. Functional outcome according to majeed score

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

Table 4. Outcome

			OUTCOME		t- Mann Whitney/ X^2	P
			Unsatisfactory 2(8.3)	Satisfactory 22(91.7)		
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 Babak Mirzashahi[10] Fourteen patients (51.9%) underwent percutaneous iliosacral screw fixation and thirteen patients (48.1%) underwent spinopelvic fixation.

Osterhhof[11] 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 agreement of our study, Nork et al. [12] found bilateral percutaneous iliosacral screw fixation to be safe and effective in treating minimally displaced sacral-U fracture.

Mirzashahi. [10] 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 were 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. [10] 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. In addition, they reported that no complication was encountered because of fixation. They also reported that this kind of fixation allow early mobilization of polytraumatized patients.

In this study satisfactory outcome group significantly younger in age and shorter in operation days similar to Routt et al[13] , Showed that delays of surgery of 5 days or longer were related to poorer closed reduction rates and Denis et al [14], 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. Importance of early surgery must be stressed in preventing the spinopelvic imbalance.

In this study 7 cases of infection 6 superficial 1 deep but Routt et al [13] 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, noncomplicance, 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 prior to healing.

In this study 1 pt had deep venous thrombosis, 3 chest infection while Kamerkar et al [15] proved that five patients (13 percent) suffered a pulmonary embolus in the early postoperative period, one of which was fatal, a 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 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., [16] found that, amongst the seven cases with neurological deficits, two cases improved completely and five cases improved partially during follow up and Bellabarba et al, [17] 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

In conclusion, 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 minimal invasive techniques, like percutaneous iliosacral fixation, are good options and for spinopelvic dissociation, spinopelvic fixation is the treatment of choice, with reasonable outcome.

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