Research Article

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Journal of Clinical & Experimental Orthopaedics
ISSN 2471-8416

2023
Vol.9 No.3:103

Outcome of Percutaneous Iliosacral Screw Fixation in Posterior Pelvic Injuries

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Received date: March 01, 2023, Manuscript No. IPJCEOP-23-2750; **Editor assigned date:** March 03, 2023, PreQC No. IPJCEOP-23-2750 (PQ); **Reviewed date:** March 14, 2023, QC No. IPJCEOP-23-2750; **Revised date:** March 24, 2023, Manuscript No. IPJCEOP-23-2750 (R); **Published date:** March 31, 2023, DOI: 10.36648/2471-8416.9.3.103

Citation: Moustafa KMK, Hammad AS, Hafez MA (2023) Outcome of Percutaneous Iliosacral Screw Fixation in Posterior Pelvic Injuries. J Clin Exp Orthopr Vol.9 No.3:103

Abstract

Background: Although the sacrum is an integral part to the biomechanics and has neurologic protective roles of the spinal column and the pelvis ring, its fractures have been relatively overlooked in the concern of spine trauma, leading to inadequate treatment and possible neurological damage.

Aim: The aim of the work is to report the radiographic and clinical results after the percutaneuos iliosacral screw fixation of posterior pelvic injuries in 30 patients.

Methods: Within the timeline from November 2012 to January 2018, 30 patients with pelvic injury were operated upon inside or outside El-Hadara University Hospital, Alexandria. Per the protocol of the study, patients have fulfilled the following inclusion and exclusion criteria.

Results: The mean postoperative Majeed score for the patients in the undisplaced fracture of posterior sacral cortex group was 102.8 ± 7.26, that for the patients in the displaced fracture of posterior sacral cortex group was 95.50 ± 9.33 and those in comminuted fracture of posterior sacral cortex group have the mean score of 79.17 ± 5.23.

Conclusion: Iliosacral screw fixation remains as effective methods for the treatment of completely unstable pelvic injuries.

Keywords: El-Hadara; Iliosacral screw fixation; Pelvic injuries; Radiographic

Introduction

Although the sacrum is an integral part to the biomechanics and has neurologic protective roles of the spinal column and the pelvis ring, its fractures have been relatively overlooked in the concern of spine trauma, leading to inadequate treatment and possible neurological damage. These fractures are a result of a wide range of injury mechanisms. Mostly from high velocity injuries as part of pelvic ring fractures, yet can occur in isolation. Also there is an increase in the detection of insufficiency fractures of the sacrum in osteoporotic elderly patients and as a pattern of low energy injuries. Biomechanically, the sacrum's function is to transfer loads from the spinal column to the pelvis, providing both strength and stability to the pelvis and lower extremities. Below the level of the second sacral vertebra, the sacrum is not considered essential for spinal column support or ambulation.

Surgical techniques for reduction and fixation of posterior pelvic injuries using iliosacral screw fixation

Could be applied either percutaneously or *via* open technique if an open reduction is needed. The position of the sacroiliac lag screw is critical. It must follow the S1 pedicle mass into the body of S1, remaining completely contained within bone throughout its path. The best purchase is obtained by using a 6.5 mm or 7 mm cancellous screw with a long (32 mm) thread length placed over a washer into the S1 body rather than into the sacral ala. Two points of posterior fixation are needed to provide stable fixation. Therefore, two fixation screws are desirable. Adequate space for the insertion of two screws into the S1 body is another concern [1]. Alternatives to a second screw in the S1 body include placing a second screw in the S2 body for patients in whom adequate space is shown to be available on the preoperative CT scan. However, insertion of the screw into the S2 body is more demanding than for S1. Although the angle for screw insertion is somewhat more straightforward, the space available (safe zone) for screw insertion leaves little margin for error. In addition, the bone stock for screw purchase may be deficient in S2, especially in the elderly. The surgeon must understand the dysmorphic variation of anatomy of the posterior pelvis and the sacrum and he should make sure that the intraoperative fluoroscopic images are available and in high-quality. Furthermore, preoperative understanding of the mechanism of injury and the three dimensional anatomy of the fractured pelvis are required for the ongoing operative reduction of the displaced fractures [2]. Within the timeline from November 2012 to January 2018, 30 patients with pelvic injury were operated upon inside or outside El-Hadara University Hospital, Alexandria. Per the protocol of the study, patients have fulfilled the following inclusion and exclusion criteria [3].

Inclusion criteria

Age group from 18 to 60 years. Reducible sacroiliac diastasis up to 1 cm. Reducible alar or transforminal sacral fractures. 4-Crescent fractures [4].

Exclusion criteria

Age group below 18 or above 60 years 2-Irreducible alar or transforaminal sacral fractures. 3- Denis type 3 sacral fractures. 4-U or Y shaped transforaminal sacral fractures. 5-Osteoporotic insufficiency fractures. 6-Lumbopelvic dissociation [5].

Posterior fixation

- Patients referring to the mechanism of fracture were classified into three groups according to Young and Burgess Classification.
- Patients with Lateral compression type of injury and included 25 patients.
- Patients with Vertical shear type of injury and Included 2 patients.
- Patients with Anteroposterior type of injury and Included 3 patients.

Materials and Methods

Preoperative assessment

Conscious and oriented patients are the best source for detailed medical history, otherwise in not fully conscious patients, paramedics and witness to the accident are the alternative source. The most important information to collect.

Personal data age, gender, address and telephone number. Injured side. Medical co morbidities. Mechanism of injury [6].

Clinical examination

Using the ATLS guidelines, a through general examination of the patient was done. Other associated injuries elsewhere in the body; extra pelvic skeletal injuries, non-skeletal injuries superficially from skin bruises or wound deep to organs such as the urinary tract, rectum and the gynecological system, Vascular examination, Neurological examination, Radiological evaluation, All patients have been assessed radiologically by [7]. Anteroposterior (AP) plain radiographs. As a part of the ATLS protocol, an anteroposterior radiograph was obtained for all patients to diagnose and classify the pelvic ring injury. Matta and Tornetta system was used to detect the vertical displacement of the pelvis in anteroposterior radiographs, which is to draw two lines from the highest points of the both femoral heads and to compare the difference between those two lines. This is repeated immediately postoperative and 6 months thereafter. Another similar way to measure the displacement using the highest points of iliac crests taking the trajectory of both to intersect the line passing through the center of the sacrum. Computed Tomography scan (CT) a routine CT scan was done for all patients preoperatively. Axial cuts were used in our study to outline the stability of the posterior sacral cortex and grouping of observations was done to include either undisplaced fractures, displaced fractures with no commination, displaced comminuted fractures [8].

Initial treatment

This included the following. External immobilization of the injured pelvis by using a circumfrential wrapping bed sheet or a pelvic binder at the level of the two greater trochanters [9].

Thromboembolic prophylaxis

Mechanically by instructing the patients to continuously moving toes and ankle and by keeping them well hydrated as well as an elastic stocking can be used if no immediate surgery was planned. Medically by using Low molecular weight heparin as a chemoprophylaxis. When no contraindication exists to it, it should be started after the injury and to be stopped 12 hours before surgery and recommence on it 12 hours after [10].

Operative treatment

An informed consent was taken from every patient who has been involved in the study. It is the use of pelvic external fixator in hemodynamically unstable patients with open book pelvis injury, whose other injuries of the abdomen, chest and brain should be dealt with urgently [11].

B De initive treatment

Antibiotics: A dose of two grams of third generation Cephalosporin is used intravenously at the induction of anaesthesia. General anesthesia or spinal analgesia was given according to the preference of the anesthetist and a urinary catheter is applied before drapping [12]. In order to detect the unstable pelvis, a two planes gentle manual distraction is done under the image intensifier which results in more displacement in vertical and horizontal directions. Both supine and prone positions allowed us to insert the iliosacral screws. Reduction of the displacement (s) and surgical approaches Closed reduction was aimed in most of the situations using a longitudinal ipsilateral leg traction for the vertical displacement and a lateral compression of the hemipelvis for the horizontal malalignment. A satisfactory reduction was checked using the in traoperative radiograph. Longitudinal traction was through manual traction over the flexed knees or by using a stinnman pin inserted in ipsilateral greater trochanter. Failure of closed trial in some cases rendered us to open on the sacroiliac joint or the sacrum to achieve the final reduction. Immediate postoperative [13].

- Recording of patients' operative data
- Medications
- Mechanical and medical thromboprophylaxis were continued.
- A postoperative antibiotics were given.

Pain killer medications were given on need

Rehabilitation: As the patient general condition was fine, mobilization was advised using crutches and toe touch weight bearing for the first 6 weeks. Partial weight bearing was allowed between 6 and 12 weeks postoperatively. Full weight bearing was allowed thereafter. An immediate postoperative radiograph was obtained before the discharge of the patient. Another follow up radiographs were obtained on the six week basis then at sixth months postoperatively. Assesment of the radiographs

was done referring back to the Matta and Tornetta grading that classified the posterior reduction according to the residual vertical displacement into [14].

- Excellent less than 5 mm.
- Good from 5 mm to 10 mm.
- Fair 11 mm-20 mm.
- Poor more than 20 mm.

Follow-up visits were arranged with the patients to be on the 6th week, 12th week and 6th month postoperatively.

Results

Tile's classification

Type B2 was monitored in most of the patients (24 patients out of 30), making the statistical significance different between the three studied groups **(Table 1)**.

out of 30 patients), whereas the rest of them had either a displaced non comminuted or displaced comminuted fracture (6 in either of them). The statistical signi icance was not different between the three groups referring to this entity (p value is more than 0.05) **(Table 2)**.

The preoperative and postoperative vertical displacement

Patients in the first group showed a significant high preoperative vertical displacement with 60% of them had displacement between 5 to 10 mm or more compared to 3 patients in other groups who showed the same preoperative displacement. There was a statistically significant improvement in the postoperative vertical displacement in all the three

Tile	Total (n=30)		YB							
			LC (n = 25)		*VS* (n= 3)		APC (n=2)		χ2	MCp
	No.	%	No.	%	No.	%	No.	%		
B1	2	6.7	0	0	0	0	2	100		
B2	24	80	24	96	0	0	0	0	32.08	<0.001*
B3	1	3.3	1	4	0	0	0	0	2	
C1	2	6.7	0	0	1	33.3	0	0		
C2	1	3.3	0	0	1	33.3	0	0		

Note: *Statistical significance.

Table 1: Distribution of the studied cases according to tile.

Stability of posterior cortex	Total (n=30)		YB							
			LC (n=25)		*VS* (n=3)		APC (n=2)		χ2	MCp
	No.	%	No.	%	No.	%	No.	%		
Undisplaced/ commination	18	60	16	64	1	33.3	1	50	3.395	0.396
Gap no commination	6	20	5	20	1	33.3	0	0		
Gap	6	20	4	16	1	33.3	1	50		

Table 2: Distribution of the studied cases according to stability of posterior cortex.

The stability of the posterior sacral cortex

Using axial cuts of the CT scan, posterior sacral cortex was observed in all patients of the three groups. Most of the patients had a non displaced posterior sacral cortex fracture (about 18

groups [15]. Comparing the means of the postoperative vertical displacements in the three groups, there was no statistical significance **(Table 3)**.

Displacement (mm)	Total (n=30)		YB						χ2	MCp
			LC (n=25)		*VS* (n=3)		APC (n=2)			
	No.	%	No.	%	No.	%	No.	%		
Pre-operative										
0-4	12	40	10	40	2	66.7	0	0		
5-10	14	46.7	12	48	1	33.3	1	50	3.596	0.497

11-20	4	13.3	3	12	0	0	1	50		
Postoperative										
0-4	27	90	22	88	3	100	2	100	0.667	1
5-10	3	10	3	12	0	0	0	0		

Table 3: Distribution of the studied cases according to displacement.

The outcome of the radiological assessment

According to Matta and Tornetta method of assessment of the quality of the reduction of the posterior pelvic injury, there were no patients in this study who had either fair or poor outcome. Twenty two patients of the first group, three of the second group and two of the third one had excellent outcome.

The difference between the two groups regarding the radiological outcome was not statistically significant **(Table 4)**.

be uncomfortable while sitting and most of them were included in the first study group (16.0%) making the significance of the statistical analysis not different according to this entity **(Table 5)**.

The relationship between Tile's classifications and the final clinical outcome Fair clinical outcome was observed in the patients with C1 and C2 Tile's injury. A higher percentage of patients with Tile's B2 injury have achieved an excellent outcome compared to those with C2 injury. However, the

Tornetta and Matta grading system	Total (n=30)		YB						χ2	MCp
			LC (n=25)		*VS* (n=3)		APC (n=2)			
	No.	%	No.	%	No.	%	No.	%		
0-4 mm Excellent	27	90	22	88	3	100	2	100	0.667	1
5-10 mm Good	3	10	2	13	0	0	0	0		

Table 4: Distribution of the studied cases according to tornetta and matta grading system.

Sitting	Total (n=30)		YB						χ2	MCp
			LC (n=25)		*VS* (n=3)		APC (n=2)			
	No.	%	No.	%	No.	%	No.	%		
Free with no pain	24	80	21	84	2	66.7	1	50	2.494	0.26
Uncomfortable	6	20	4	16	1	33.3	1	50		

Table 5: Distribution of the studied cases according to the ability of sitting.

The ability of sitting postoperatively

The postoperative ability of sitting was free and of no pain in 24 patients of the three groups. About 6 patients only reported to

statistical analysis failed to show a significant correlation (p value=0.628) **(Table 6)**.

Tile	N	Final clinical outcome Majeed score			Test of Sig.	p
		Min-Max.	Mean ± SD	Median		
B1	2	77.0-106.0	91.50 ± 20.51	91.5		
B2	24	71.0-106.0	98.04 ± 11.08	106		
B3	1		81		F=0.657	0.628
C1	2	79.0-106.0	92.50 ± 19.09	92.5		
C2	1		96			

Table 6: Relation between Tile's classification and final clinical outcome.

The relationship between the stability of the posterior sacral cortex and the final clinical outcome.

There was an intimate correlation between them, the more the gapping or comminution of the posterior sacral cortex, the worse is the final clinespecially to the assessment and the ability to sitting or standing without pain. The statistical difference was significant (p value=0.001) **(Table 7)**. Statistical scores and outcome. This was related the relationship between the preoperative and postoperative fracture displacement and the final clinical outcome.

Although patients in this study had improvement in their fracture displacement measurements postoperatively, they made no effect regarding the final clinical outcome **(Table 8)**.

The relationship between Tile's classification and the final radiological outcome None of the patients with C2 pelvic injury had a fair radiological outcome. All other patients with either B or C injury have had a satisfactory (good or excellent) radiological reduction of their posterior pelvic injury. Statistically, the Tile's grade did not affect the radiological outcome **(Table 9)**.

Discussion

Although many studies have examined the outcome of pelvic ring injuries, to our knowledge there is no data in the literature concerning the functional outcome of unstable pelvic fractures after the use of either single or two iliosacral screws taking in consideration the stability of the posterior sacral cortex as a possible controlling factor. Biomechanical studies were published; this showed that one single screw in an *in vitro* fracture model was able to restore the biomechanical conditions similar to that of the intact pelvis. Two other biomechanical studies done and Van Zwienen proved higher stability with two screws in vertically unstable fractures.

However, the problem in the clinical setting is still present motivating the surgeons to keep searching for other factors like variation in type of injury, energy of trauma, severity of fracture, degree of displacement, associated injuries of the pelvis or other fractures and the addition of fixation.

Stability of posterior cortex	N	Final clinical outcome Majeed score			Test of Sig.	p
		Min-Max	Mean ± SD	Median		
Un displaced	18	78.0-106.0	102.8 ± 7.26	106		
Gap no commination	6	82.0-106.0	95.50 ± 9.33	95.5	F=23.131	
Gap/commination	6	71.0-106.0	79.17 ± 5.23	79.5		<0.001

Table 7: Relation between the stability of the posterior sacral cortex and final clinical outcome.

Displacement (mm)	N	Final clinical outcome Majeed score			Test of Sig.	p
		Min-Max	Mean ± SD	Median		
Pre-operative						
0-4	12	78.0-106.0	98.58 ± 10.13	105		
5-10	14	79.0-106.0	98.57 ± 10.32	106	F=3.190	0.057
11-20	4	71.0-106.0	83.75 ± 15.39	79		
Postoperative						
0-4	27	71.0-106.0	97.22 ± 11.64	106	t=0.868	0.393
5-10	3	80.0-106.0	91.0 ± 13.45	87		

Table 8: Relation between the preoperative and postoperative fracture displacement and final clinical outcome.

Tile	Radiological outcome of posterior reduction				χ^2	MCp
	0-4 mm Excellent (n=27)		44839 mm Good (n=3)			
	No.	%	No.	%		
B1	2	7.4	0	0		
B2	21	77.8	3	100		
B3	1	3.7	0	0	2.509	1
C1	2	7.4	0	0		
C2	1	3.7	0	0		

Table 9: Relationship between Tile's classification and the final radiological outcome.

Needed for the anterior pelvic fractures; so we mainly compared our results to clinical series. The union rate was similar to the series of 48 patients by Tornetta and Matta and the series of Suzuki et al. with 57 patients, both had no non-union. Late displacement in a series by Matta and Saucedo occurred in 3 out of 29 patients all of whom had bilateral unstable posterior fractures (one of the three started weight bearing after 1 week against advice). Griffin et al. showed that fixation failed in 4 out of 62 patients all with vertical sacral fractures (13%) by 3 weeks, they added that there was no significant association between failure and anterior fixation method, accuracy of posterior reduction, iliosacral screw arrangement or length or any demographic or injury variable, however, no attempt has been made to infer clinical outcome. So their results do not reflect the impact of redisplacement on functional outcome. Debate continues. Regarding the definition of adequate reduction of the pelvicring and how malreduction affects the outcome, if at all. Our functional results are comparable and even a little better to Matta and Saucedo where the results at follow-up evaluation were 76% satisfactory and 24% unsatisfactory in the patients treated with internal fixation.

Used Sickness Impact Profile (SIP), which consists of 136 statements in 12 categories, 77% of their patients had mild disability (SIP<10), 23% had moderate disability (SIP>10) and none had severe disability (SIP<30). Evaluated their functional results using a standard clinical questionnaire about return to work, ambulation, pain and muscle strength. In a study, two scoring systems were used, they used the Majeed score and the SF-36, their patients scored 78.6/100 on the Majeed score. In their series, 40% of patients reported changes in only 39% were able to sit without complaints. Suzuki et al. Reported an average Majeed score of 79.7 (30-100) points in 57 patients. Unfortunately we could not compare many of the recent case series because they did not evaluate functional outcome, instead they have focused more on technical aspects regarding fluoroscopy techniques, use of CT, biomechanical studies on stability, assessment of adequate screw position and incidence of complications. In this series, there was no statistically significant difference between number of screws used in posterior pelvic fixation and functional results p value 0.051 (one screw mean Majeed score 94.62 ± 12.85, range 71.0-106.0 and for two screws: score 92.89 ± 12.69, range 77.0-106.0). These results are similar to Sagi et al. but did not match the biomechanical studies by Yinger et al. And Van Zwienen et al. That suggested the superiority of two points of posterior fixation for the treatment of type C unstable pelvic ring injuries. Taking in consideration the stability of the posterior sacral cortex, there was a statistically significant difference between the studied groups with each other regarding functional results, p value<0.001 Undisplaced sacral.

Conclusion

Iliosacral screw fixation remains as effective methods for the treatment of completely unstable pelvic injuries. Fixation of the anterior pelvic injury, although did not affect the final clinical outcome, may add more stability to the posterior pelvic fixation in the treatment of completely unstable pelvic injuries. Posterior sacral cortex injury does not affect the radiological outcome of the patients, yet it still an important underlying cause of the low satisfaction of surgery by the patients. fracture group mean Majeed score 102.8 ± 7.26 with a range 78.0-106.0, in Displaced sacral fracture group mean Majeed score 95.50 ± 9.33 with a range 82.0-106.0 and for comminuted sacral fracture group 79.17 ± 5.23 with a range 71.0-106.0). These results are similar Who claimed that the early hard ware failure and worse functional results are by using the iliosacral screw alone in comminuted sacral fractures. The comparison of the individual type of posterior sacral cortex fracture and radiological outcome did not reach statistical significance (p value 0.186). This result further simulate the work done by Ayoub MA who stressed in his conclusion on the unsatisfactory functional. Results after the fixation of comminuted sacral fractures even after the radiological union of the fractures themselves. The strength of our study lies in being the first to look for function in relation to previously studied parameters and the use of a specific grading for function after pelvic fractures. The weakness lies in the small number of patients in the three different comparison groups.

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