Evaluation of iliosacral screw for fixation of posterior pelvic ring disruption

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Abstract:

Background:
The sacroiliac joint lies next to the spine and connects the sacrum [the triangular bone at the bottom of the spine] with the pelvis [iliac crest] and transmits the load of the body to the lower extremities. Pelvic ring disruptions occur as a result of high-energy trauma, which are associated with transverse fractures and dislocation of sacrum and sacroiliac joint [unilateral or bilateral

Patients & Method:
Twenty polytrauma patients with pelvic injuries were included in this prospective study to evaluate the benefits of percutaneous iliosacral screwing. All patients were followed up for at least 6 months, and their mean age was 32 years. According to Tile's classification, all cases were type C pelvic injuries. After primary anterior fixation, the iliosacral screws were applied percutaneously.

Results:
Eleven cases had excellent reduction, 5 cases had good reduction, 3 cases had fair reduction and one case had poor reduction. The unsatisfactory final displacements were common among dislocations of the sacroiliac joints and operated cases during the second week. The final clinical outcome was satisfactory in 15 cases and unsatisfactory in 5 cases. Unsatisfactory clinical results were due to persistent posterior pelvic pain and limited activities in 4 cases and residual neurological disability in one case. No posterior infection was encountered; however, two cases had loosening of the applied improper screws. There was significant direct reduction in the hospital stay, transfused blood amount, ventilator time and complications when the percutaneous iliosacral screwing was carried out early during the first week. Therefore, indirect reduction in the hospital cost and polytraumatized patient morbidity was achieved.

Conclusion:
Iliosacral screw fixation for Posterior pelvic ring disruption is safe and minimally invasive technique. The use of iliosacral screws for posterior unstable pelvic ring injuries yields well to excellent functional results.

Keywords:
Unstable pelvic ring injuries · Percutaneous iliosacral screws

Introduction:

The sacroiliac joint lies next to the spine and connects the sacrum [the triangular bone at the bottom of the spine] with the pelvis [iliac crest] and transmits the load of the body to the lower extremities [1].

Pelvic ring disruptions occur as a result of high-energy trauma, which are associated with transverse fractures and dislocation of sacrum and sacroiliac joint [unilateral or bilateral] [2, 3].

Analysis indicates that motion of the sacroiliac joint is complex and cannot be described with a single horizontal axis. An approximated transverse rotational axis can be projected posteriorly to the sacroiliac joint between the first and the second sacral bodies with a moving position under load [4, 5].

Formerly, sacral injuries were treated conservatively due to the lack of implants and techniques capable to reduce and stabilize the fractures. In these cases, a long period of bed rest was required, and clinical complications related to prolonged immobilization were common [6].

Nowadays, the orthopedists' attitude toward treatment of fractures has been changed and rapid fixation and early mobilization have become popular options. Currently, vertical instability and posterior disruption are two approved indications for stabilization of pelvic ring disruptions [7].

Surgical stabilization has allowed early mobilization and short- term outcomes improvement, however, excellent long-term outcomes have not occurred in the same proportion [7- 9].

Anterior pelvic injuries can be stabilized by plating or external fixators; however, the selection of a fixation method for the posterior lesion, which is more important, is controversial. Although posterior approaches with plating, sacral bar and triangular fixation systems have been used until now, they need a wide exposure in the prone position, which can increase the rate of infection, wound sequelae and anesthesia problems especially in the high-risk polytraumatized patients [10-11].

Patients and methods

From March 2019 till the end of March 2020 at orthopedic department Menoufia University Hospital, Al Kasr Al Aini university Hospital and Tanta University Hospital, twenty polytraumatized patients with unstable pelvic ring injuries were managed with percutaneous iliosacral screws fixation. Cases with open fracture, pathological fracture and fractures with associated neuro-vascular injuries were excluded. Written informed consent was obtained from all patients. Any possible complications were notified for all patients and were written in the consent.

All patients had initial intensive care unit admission and were followed up for a mean of 6 months (range 4-8 months). There were 12 men and 8 women, with a mean age of 32 years (range 22-48 years). The mechanisms of the injuries were road traffic accidents (RTA) in 14 patients, a fall from a height in 4 patients, and a crushing work-related injury in 2 patients as shown in Table 1. All patients had associated injuries or fractures, Initial mechanical and then chemical (low molecular weight heparin) prophylaxis against deep vein thrombosis (DVT) were used in all patients.

A pre-operative radiological evaluation, anteroposterior (AP), inlet and outlet views of the pelvis was carried out in addition to computed tomography (CT) scans to evaluate the exact characteristics of the fractures. All cases were type C according to Tile's classification. In the posterior pelvic ring injuries, there were 3 sacroiliac joint dislocations and 17 sacral fractures, 5 were type I and 12 were type II according to Denis et al.'s classification.

All patients were placed in a supine position on a radiolucent table. The posterior ring was indirectly reduced and maintained after the primary procedure for the anterior arch. After obtaining an adequate lateral view under the fluoroscopic guide, the entry point for the iliosacral screw was determined. With the guidance of the pelvic AP, outlet and inlet views, guide wire inserted, almost perpendicular to the midline inserted from the outer table of the iliac wing towards the body of sacral one vertebra. Care was taken to avoid intrusion into the sacral canal posteriorly or the sacral foramen inferiorly. Drilling was done, and then a washered cannulated screw was inserted over the guide wire. The screw was tightened, alternatively, until the fractured surfaces were approximated without over-compression especially in comminuted sacral fractures. postoperative lateral decubitus or semi-sitting position is allowed, the patients are encouraged to do active or passive functional exercises three days after the operation, Crutch-assisted walking was allowed three weeks after the operation, Partial weight bearing was allowed in a month and Full weight bearing in three months. The radiological results relied on the maximal vertical or anterior–posterior displacement reached at the end of the follow-up periods of each patient. The results were classified according to Lindahl et al. [10] into the following groups: excellent (0–5 mm displacement), good (6–10 mm), fair (11–15 mm) and poor (more than 15 mm displacement).

Fig. 1 A: Pre-operative plain inlet view of 23 years old male patient shows the widely separated symphysis pubis anteriorly with right sacroiliac joint dislocation posteriorly. **B:** The axial CT scan cut shows type C Tile's pelvic ring fracture. **C:** The plain AP view after 10 months that shows excellent radiological results; the patient achieved good clinical result.

Table 1 Demographic data of the patients

Variable	Number	Percentage
Males	12	60
Females	8	40
22-30	11	55
31-40	6	30
41-48	3	15
Right	12	60
Left	8	40
Car occupants *	11	55
Pedestrians *	3	15
Fall from height	4	20
Work-related injuries	2	10
Head injuries	1	5
Chest injuries	3	15
Abdominal injuries	1	5
Urogenital injuries	1	5
Extremity injuries	13	65
Spinal fractures	2	10
Non-displaced acetabular fractures	4	20
Morell-Lavallee lesions (MLL)	1	5
Symphysis pubis diastasis	9	45
Pubic bone fractures	11	55
Sacral fractures zone 1	3	15
Sacral fractures zone 2	15	75
Sacroiliac joint dislocations	2	45
1st 3 days	2	10
4-7 days	11	55
8-14 days	7	35
<2 weeks	4	20
2-4 weeks	13	65
>4 weeks	3	15
≤ 15 mm	17	85
> 15 mm	3	15

* *RTA* road traffic accident

The functional results were classified according to Lindahl et al.'s modification of Majeed score into the following groups: excellent78–80 points), good (70–77 points), fair (60–69 points) and poor (<60 points) [10, 11]. We categorized excellent or good as a satisfactory result and fair or poor as an unsatisfactory result.

Statistical analysis was carried out using SPSS version 20 **(Statistical Package for the Social Sciences).** Tests of significance (Kruskal-Wallis, Wilcoxon's, Chi square, logistic regression analysis, and Spearman's correlation) were used. Data were presented and suitable analysis was done according to the type of data (parametric and non-parametric) obtained for each variable. P-values less than 0.05 (5%) was considered to be statistically significant.

Results

The final clinical outcome in this study was satisfactory in 13 cases (65%) and unsatisfactory in 7 cases (35%), as 5 cases had excellent scores, 8 cases had good scores, 5 cases had fair scores and 2 cases had poor scores. Unsatisfactory results were due to persistent posterior pelvic pain and limited activities in 7 cases.

The final radiological results were satisfactory in 16 cases (80%) and unsatisfactory in 4 cases (20%), as 9 cases had excellent reduction (Fig. 1), 7 cases had good reduction, 3 cases had fair reduction and one case had poor reduction. The unsatisfactory final displacement was common among: the age groups more than 40 years old, dislocations of the sacroiliac joints, comminuted zone II sacral fractures, operated cases during the second week and cases with initial displacement more than 20 mm before surgery. The clinical outcome was better significantly in the age groups below 40 years old and with 15 mm or less initial displacement. It was better insignificantly among sacral fractures cases and cases operated during the first week. The presence of MLL had insignificant effect on the final clinical and radiological results as shown in Table 2. The radiological outcome was better significantly among the younger age groups, sacral zones I and II fractures, operated cases during the first week and cases with 15 mm or less initial fracture displacement as shown in Table 2. Although the supraacetabular external fixator shared anterior plating in the satisfactory clinical and radiological results (Fig.2).

Iliosacral screwing during the first week had strong impact on the hospital stay duration and on ventilator time; also, it has lowered significantly the needed total amount of transfused blood

before and after its application as shown in Table 3. The average posterior operating time was 50 min (25–70), and the average total screening time was 240 s (90–390). Blood loss was always less than 50 ml without any deterioration in the hemodynamic parameters. No mandatory blood transfusion was requested due to the percutaneous iliosacral screwing in any of our cases. Regarding complications, iatrogenic nerve injury was encountered in one case due to fixation in this study. Two cases had superficial pin tract infection of the supra-acetabular external fixators and no case developed posterior infection.

Table 2 Variables related to the clinical and radiological results with their statistical significance

Variables	Clinical results				Radiological results			
	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
	cases	cases	cases	cases	cases	cases	cases	cases
22–30	4	4	2	1	7	2	1	1
31–40	1	3	2	0	1	4	1	0
41–48	0	1	1	1	1	1	1	0
Sacral zone I	1	1	1	0	1	2	0	0
Sacral Zone II	3	6	4	2	7	4	3	1
Sacroiliac joint	1	1	0	0	1	1	0	0
1st three days	2	0	0	0	2	0	0	0
4–14 days	3	7	1	0	7	4	0	0
15-21 days	0	1	4	2	0	3	3	1
≤15 mm	5	8	4	0	8	7	2	0
>15 mm	0	0	1	2	1	0	1	1
Absent	5	7	5	2	8	7	3	1
Present	0	1	0	0	1	0	0	0
Plate	3	4	2	1	6	3	1	0
External fixator	2	4	3	1	3	4	2	1

Discussion

High-energy fractures of the pelvis are a challenging problem in both the immediate post-injury phase and the later when definitive fixation is undertaken [**12**]. Although they are uncommon, but when they do occur, they pose an extensive disruption of the pelvis, and can greatly contribute to significant patient morbidity and mortality [**13**], early operative stabilization has been recommended to reduce mortality, to promote early rehabilitation and to diminish the complications **[14].**

Young patients with pelvic ring fractures or injuries due to high-energy trauma should be initially assessed by a multidisciplinary team, because they often have multiple injuries and are subject to major bleeding. Bleeding in this type of injury is more severe when associated with unstable pelvic fractures, which although infrequent, present a high mortality rate. In turn, elderly patients with fractures due to minor trauma generally do not present complications [**15**].

This was prospective study that was conducted on 20 patients with posterior pelvic ring disruption at Menoufia University Hospital, Kasr Al Aini hospital and Tanta university hospital.

On analysis of demographic characteristics of the studied cases, we revealed that age of the patients ranged 22 – 48 years with Mean ± SD was 32.01 ± 8.78, and 60% of patients were males.

In agreement with our study, the study of **Ayoub, [16]** that aimed to evaluate the benefits and the functional outcome of two percutaneous iliosacral screws fixation, applied only under C-arm control as early as possible for polytraumatized patients with highly unstable posterior pelvic ring injuries and reported that majority of participants 38.1 % their age ranged 21 – 30 years with 78.6% of patients were males.

In contrary to our findings, the study of **Pereira et al., [17]** that aimed to evaluate the pelvic ring fractures and injuries in patients admitted to and treated at this ward between August, 2012 and January, 2014, and reported that age of the individuals analyzed ranged from 3 to 86 years (mean of 47). Mean age in relation to sex was 55.3 years for females and 41.9 years for males. As for sex, there was predominance of males (57.5% of the sample).

As regard comorbidities among the studied cases, the present study revealed that Smoker is the commonest comorbid among the studied patients, 10% had DM and 15% had HTN.

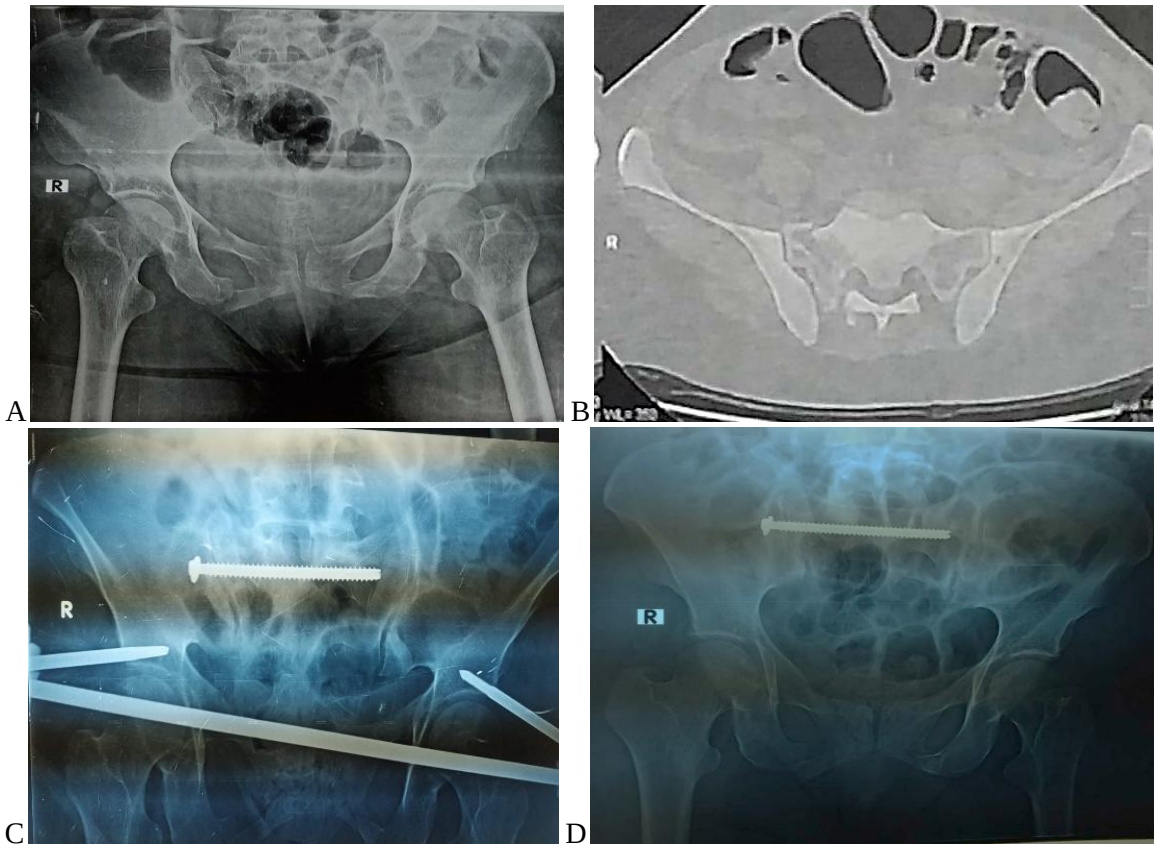

Fig. 2 A: The plain AP view of 39-year-old male patient after falling from 1st floor shows type C injury of the *right* hemipelvis with ipsilateral superior and inferior rami fracture anteriorly and sacral fracture posteriorly **B:** The axial CT cut shows zone II *right* sacral fracture. **C:** The postoperative plain AP view after primary supraacetabular internal fixator application and washered percutaneous iliosacral screws application. **D:** The plain AP view after 6 months with good radiological score and excellent functional score.

Table 3 The effect of timing of iliosacral screwing on hospital stay, transfused blood and ventilator time.

Onset of iliosacral screwing	Hospital stay			Transfused blood before iliosacral screwing	Transfused blood after iliosacral screwing	Ventilator time (days)
	<2 weeks	2-4 weeks	>4 weeks			
1st 3 days	1 case	1 case	0 case	1,500 cc	500 cc	3
4–14 days	3 cases	7 cases	1 case	2,500 cc	1,000 cc	4
15–21 days	0 case	5 cases	2 cases	3,000 cc	1,500 cc	6

In another study of **Hsieh et al., [18]** that was designed to investigate the impact of pelvic fracture on the outcome of trauma patients, and reported that there was a significantly lower incidence rate of preexistent comorbidities such as HTN and ESRD in patients with pelvic fracture than those without. No significantly different incidence rates of comorbidities such as DM, CAD, and CVA were found between patients with or without pelvic fracture.

Regarding fractures characteristics of the studied patients, the present study revealed that Of the 20 hemipelves treated with sacral screws, Bilateral both Rami Fractures in 6, Unilateral Rami Fractures in 5, two cases had right iliac wing Fracture, two cases with Lumber spine Fracture, 5 cases with lower extremity fracture and 6 cases with upper extremity fracture which allowed the classification of these fractures according to AO Tile modified classification; and all 20 patients had a fractured pelvis type C.

In another study of **Pereira et al., [17]** that reported that regarding the classification of pelvic ring injuries, the authors emphasize that in the present study, of all fractures/injuries, type A (stable) was the most frequent and, among these, subtype A2.3 (isolated fracture of the anterior region of the ring – one or four branches) was the

most common. These were followed by types B (rotationally unstable and vertically stable) and C (rotationally and vertically unstable).

As regard cause of pelvic fracture, the current study demonstrated that the cause of injury was a motor vehicle crash in 11, a pedestrian struck by a motor vehicle in 3, a fall from a height in 4, and an industrial accident in 2.

Comparing to the study of **Ayoub, [16]**, in which Injury mechanism among studied cases were as follow: Car occupants by 23.8%, Pedestrians 26.2%, Motorcycle 19%, Fall from height by 19% and Work-related injury in 11.9%.

In a harmony with the present study, the study of **Pereira et al., [17]** observed that, in general, accidents involving transportation vehicles (cars/trucks and motorcycles) were the most frequent causes of injuries, accounting for 45.3% of the total. When including the mechanism "being run over" (also caused by the same type of vehicle), total of injuries caused by traffic accidents was 57.5%, which reinforces the fact that these injuries were caused, for the most part, by motor vehicles, also we are supported by the study of **Devarinos et al**., **[19]** in a long follow-up of pelvic ring injuries (10 years), indicated that the most frequent injury mechanism was traffic accidents (74%). **Freitas et al**., **[20]** in a literature review of studies on pelvic ring fractures in recent decades, observed that the most prevalent trauma mechanisms were those related to traffic. **Chueire et al**., **[21]** reported that pelvic ring injuries were caused by car accidents in 23% of cases and by motorcycle accidents in 19%.

In the present study, we assessed maximal residual displacement of the studied patients after 6-weeks follow up and revealed that 9 patients were excellent outcome, 7 patients were good, 3 patients were fair, and one patient was poor outcome.

In contrary to study, the study of **Khaled et al., [22]** reported that radiologically excellent residual displacement was achieved in 55 patients, good in 16, fair in six patients, and none had poor reduction

In the study of **Zaki et al., [23]**, radiologically, 19 cases had excellent results, 13 cases had good results, five cases had fair results, and three cases had a poor result. All unsatisfactory radiological results were owing to residual posterior displacement noticed postoperatively in six cases and loosening without loss of posterior reduction in two cases during the follow-up period.

While as regard Functional outcome of the studied patients after 6- weeks follow up, The functional results were classified according to the Lindahl et al.'s score we found that, 5 patients were excellent, 8 patients were good, 5 patients were fair, and 2 patients were poor, and we found that All the score domains and the overall score were significant increased from immediately to 6-weeks postoperatively.

In a harmony with our study, the functional results of the study of **Zaki et al., [23]** were classified according to the Lindahl et al.'s modification of the Majeed score into the following groups: excellent (78–80 points), good (70–77 points), fair (60–69 points), and poor (<60 points). Regarding function, 31 (77.5%) cases achieved satisfactory results, 11 excellent (eight of group I and three of group II), and 20 good results (nine of group I and 11 of group II). All unsatisfactory functional results were mainly because of the residual posterior SI pain and limited activities. Overall, nine (22.5%) cases achieved unsatisfactory results: eight cases had fair results, with three of group I and five of group II (six cases owing to postoperative residual pain with walking distance affection and using walking aids, and two cases owing to postoperative residual pain with affection of sitting and sexual function) and one case had poor result in group II (owing to residual pain, sitting affection, walking distance affection, gait affection, and using walking aids).

Kokubo et al., [24] reported that eighty-two patients with unstable pelvic ring fracture were evaluated for clinical and radiological outcome at 1 year after injury (short-term) and at final follow-up (long-term), with minimal follow-up period of 26-month period and mean follow-up of 89 months (range, 26–187). Functional outcome was assessed by the Majeed score, 21 which is a pelvic injury-specific functional assessment divided into seven items: pain, work, sitting, sexual intercourse, standing, gait unaided, and walking distance, with a total score range of 0–100 in order of decreasing disability.

As regard sciatic affection and neurological lesions in our cases, 2 patients had sciatic injury due to trauma 1 of them were healed postoperatively and one patient still not healed. Among the 19 patients, there was one patient had sciatic injury because of the fixation.

In agreement with our study, the study of **Kokubo et al., [24]** nerve damage associated with the pelvic ring fracture and/or associated injuries in 14 (17%) including 5 patients with lumbosacral plexus injury, 4 with sciatic nerve injury, 2 with the fifth lumbar nerve injury, and 3 with spinal cord injury.

The outcome of a pelvic ring injury is related to the type of fracture, the quality of reduction of the posterior pelvic complex, the presence of neurological injury and of associated injuries.

Permanent disability is due to chronic pain in the posterior pelvis or low back, persisting pelvic instability or pelvic deformity (causing apparent leg length difference or sitting imbalance), nerve injury (neuralgia, paralysis), genitourinary or bowel dysfunction (urethral stricture, impotence, incontinence, dyspareunia), and other limb injuries. When treated non-operatively, long-term pain and disability have been reported in 40% of patients after stable Type A fractures, 55% of Type B and 90% of Type C fractures [25]. Surgical fixation of the unstable pelvic ring improves the outcome [26].

Studies from Germany and USA have reported a good or excellent outcome in 79% of patients after internal fixation of Type B injuries but in only 27% in Type C cases, with patients being pain free in 69-89% of Type B and 33-50% of Type C injuries. Neurological injuries (L5, S1 or lower sacral roots) have a poor prognosis, being a cause of permanent disability in one-third of patients with Type C fractures [27].

Conclusion

Iliosacral screw fixation for Posterior pelvic ring disruption is safe and minimally invasive technique. The use of iliosacral screws for posterior unstable pelvic ring injuries yields well to excellent functional results.

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