

RESEARCH ARTICLE

Spinopelvic Fixation of Sacroiliac Joint Fractures and Fracture-Dislocations: A Clinical 8 Years Follow-Up Study

Mohammad R. Sobhan, MD; Seyed Mohammad J. Abrisham, MD; Mahmood Vakili, MD; Saeed Shirdel, MD

Research performed at Department of Orthopedic Surgery, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

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Abstract

Background: Pelvic ring injuries and sacroiliac dislocations have significant impacts on patient's quality of life. Several techniques have been described for posterior pelvic fixation. The current study has been designed to evaluate the spinopelvic method of fixation for sacroiliac fractures and fracture-dislocations.

Methods: Between January 2006 and December 2014, 14 patients with sacroiliac joint fractures, dislocation and fracture-dislocation were treated by Spinopelvic fixation at Shahid Sadoughi Training Hospital, Yazd, Iran. Patients were seen in follow up, on average, out to 32 months after surgery. Computed tomographic (CT) scans of patients with sacral fractures were reviewed to determine the presence of injuries. A functional assessment of the patients was performed using Majeed's score. Patient demographics, reduction quality, loss of fixation, outcomes and complications, return to activity, and screw hardware characteristics are described

Results: The injury was unilateral in 11 (78.5%) patients and bilateral in 3 (21.5%). Associated injuries were present in all patients, including fractures, dislocation and abdominal injuries. Lower limb length discrepancy was less than 10 mm in all patients except two. Displacement, as a measure of quality of reduction was less than 5 mm in 13 patients. The mean Majeed score was 78/100. Wound infection and hardware failure were observed in 3 (21.4%) and 1 (7.1%) cases, respectively. In this study most patients (85%) return to work postoperatively.

Conclusion: According to the findings, spinopelvic fixation is a safe and effective technique for treatment of sacroiliac injuries. This method can obtain early partial to full weight bearing and possibly reduce the complications.

Keywords: Dislocation, Fractures, Sacroiliac joint, Spinopelvic fixation

Introduction

Pelvic ring disruptions are relatively uncommon injuries with a prevalence of nearly 20-37/100,000 in general population. Typically, 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) (1,2). These disruptions and consequent sacroiliac dislocations have a significant impact on patient's quality of life (3). In the past decades, most of the pelvic fractures were treated with skeletal traction and bed rest, owing to issues such as lack of proper surgical techniques and appropriate fixation devices, and consequently, uncertain surgical outcomes. Nowadays, the orthopedists' attitude toward treatment of fractures has been changed and rapid fixation and early mobilization have become popular options (4).

Currently, vertical instability and posterior disruption

are two approved indications for stabilization of pelvic ring disruptions (5). Different methods are available for fixation of sacroiliac joint fractures and fracture-dislocations, including the use of iliosacral screws, anterior or posterior sacroiliac plates, trans-iliac treated compression rods, open or percutaneous sacroiliac screw fixation under fluoroscopic guidance, and sacroiliac fixation using a sacral screw and lateral pressure on the iliac wing with the Galveston technique (6-13). Obviously, each method has its own advantages and disadvantages, and should be considered on a case-by-case basis (4). By that means, fixation of these injuries remains challenging, as a result of complex local anatomy, unique biomechanical forces, and poor bone quality (14).

Considering the importance of these injuries in survival and quality of life, and with regard to the need for a study of large population in longer-term, we aimed to assess the

Corresponding Author: Seyed Mohammad J. Abrisham, Department of Orthopedic Surgery, Shahid Sadoughi Hospital, Bou Ali Avenue, Safaieh, Yazd, Iran
Email: smj_abrisham@gmail.com



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results of spinopelvic fixation (SPF) techniques by spine instrumentation in fractures and fracture-dislocations of the sacroiliac joint.

Materials and Methods

This study was approved by Shahid Sadoughi University of Medical Science Ethics Committee, Yazd, Iran. A written informed consent was obtained from all patients. In a retrospective study, we assessed the outcomes of SPF techniques in 14 patients aged 18-80 years and with pelvic fractures referred to Shahid Sadoughi hospital, Yazd, Iran between 2006 and 2014. All patients underwent plain X-rays (Chest X-Ray and Inlet-Outlet views) and computed tomography (CT) scan before operation to determine the exact shape of the pelvic fracture and the corresponding surgical plan.

All patients with Sacroiliac Joint fractures and fracture-dislocations were included. The collected data included demographics (such as age, gender), reduction quality, loss of fixation, complications and outcomes, and return to activity.

Spinopelvic Fixation

The patient was positioned in prone position on a spinal surgery frame; a vertical median incision was made over the L5 vertebra (traction used if necessary). The subcutaneous tissues were dissected down to the posterior iliac crest, ipsilateral to the sacroiliac injury; Then, L5-S1 joint and the posterior surface of the sacrum from S1 to S3 was exposed through a median incision (5). Paraspinal muscles were elevated from the dorsum of the sacrum and reflected medially. Nerve decompression was performed if indicated, either through removal of bony fragments within the foramen or with a midline sacral laminectomy. Pedicle screws (5 mm) were placed on each side at L5 level as described by Canale et al. (15). Alternatively, fixation was performed at S1 level. This was done when there was definitely no sacral fracture. If both S1 and L5 fracture fixations were done, the two iliac screws were connected with a rod [Figure 1].

Two 7-mm iliac screws were inserted through sacroiliac connectors placed on a rod linking the two sacral screws. The iliac screws (range from 60 to 80 mm) were driven into

the posterior iliac crest and secured into the cancellous mass of the posterior ilium (5). We have used two screws in some; the first screw had an upward direction and the second was driven slightly downwards, toward the greater sciatic notch. The rods were bent appropriately and attached the pedicle screws to the iliac screws and left loose. The reduction was obtained and then maintained by locking down the rods to the screws (15) [Figure 2].

Post-op evaluations

Patients were ambulated with assistance within 2 to 5 days after surgery. All patients were discharged with partial weight bearing and were followed monthly for a minimum of 6 months. Majeed Index questionnaire, quality of reduction (displacement in plain x-ray), limb length discrepancy and the amount of vertical displacement were determined in the follow-up visits (16). Complete weight bearing was encouraged after complete union and absence of any side effects.

Results

During January 2006 and December 2014, 420 patients were admitted to Shahid Sadoughi hospital with pelvic fractures. In this period we have applied SPF technique in 14 patients. Patient's characteristics are summarized in Table 1. The mean age was 37.9 ± 7.18 years (range: 18-80 years) and follow-up was at an average of 32 months (range: 6-56 months).

The mean injury-to-surgery time was 27 days (range: 4 - 180 days) among all patients. This time would be 12.8 days (range 4 to 24 days) excluding patients with long delays (Patients 9 and 14). Patient 9 was referred after failure of treatment strategies with a 45-day delay. Patient 14 was admitted after 180 days with traumatic sciatic nerve palsy and non-union [Table 2].

Pre and post-operative neurological symptoms were observed in two (Patients 10 and 14) and one patients (Patient 14), respectively. Material prominence was observed in seven patients, three of whom needed hardware removal. Hardware removal was also performed due to pain in three different patients without material prominence.

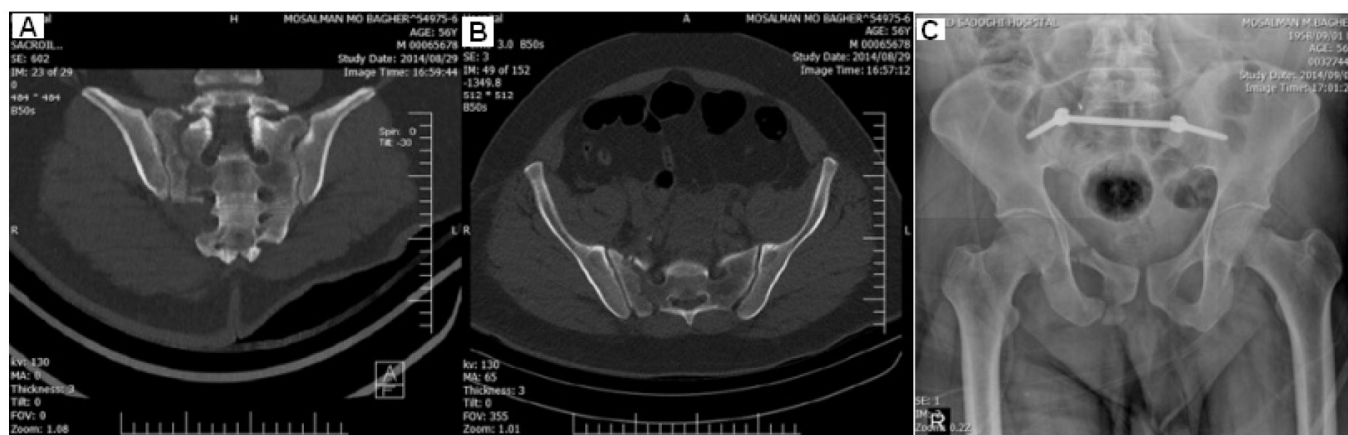


Figure 1. Patient 2: SPF with two iliac screws in sacral and pubic fractures. Sacral fracture coronal view (A), sacral fracture axial view (B), and SPF with two iliac screws and rod (C).

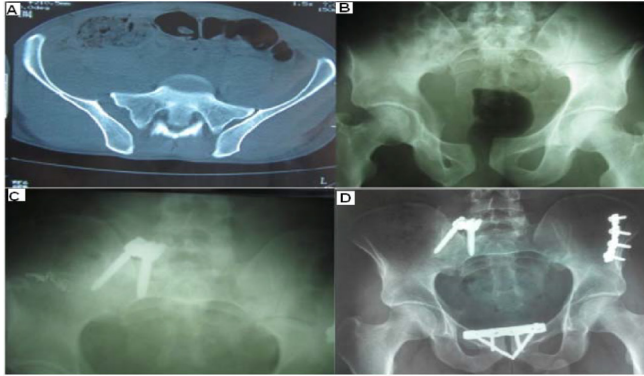


Figure 2. Pre-operation CT scan and radiography of patient 4 that display sacroiliac dislocation, iliac fracture and diastasis of pubic symphysis (A and B) and post-operation radiographies for the patient that display sacroiliac, iliac and pubic symphysis fixation (C and D).

The mean Majeed score was 78.14 [Figure 3]. Scores lower than 70, was found in three cases, two of which were the eldest patients (Patients 2 and 6). Lower limb length discrepancy was less than 10 mm in all patients except two cases. Eight (57.1%) patients had less than 5 mm and four patients had 10 mm limb length discrepancies.

Displacement was less than 5 mm in 13 cases. Patient

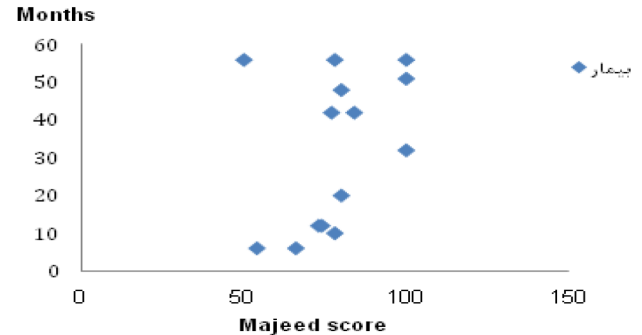


Figure 3. Majeed score during 56 months follow for 14 patients.

9 with a 55 mm pre-operation displacement, inadequate traction, and 45 days delay failed to achieve the ideal quality (>15mm).

Postoperative complications were observed in 28.6% cases, including deep tissue infection (21.4%) hardware failure (7.2%) [Table 2]. Traumatic sciatic nerve palsy occurred with full recovery in one case. All dislocations achieved union after 6 months. In addition, no sacral or iliac screw loosening, loss of reduction, non-union or mal-union was seen. The patients' return to work is summarized in Table 3.

Table 1. Preoperative characteristics of patients enrolled in the study

Patient	Age	Sex	Type	Side	Mechanism	Associated injuries
1	40	Female	Dislocation	Left	Accident	Bilateral acetabular fx* Ramus of pubis fx Tibial fx
2	56	Male	Fracture	Right	Falling	Pubic fx Femoral trans process fx
3	35	Male	Dislocation	Left	Accident	Pubic dx** Liver rupture
4	36	Male	Dislocation	Right	Falling	Pubic dx Iliac fx
5	33	Male	Fracture-dislocation	Right	Accident	Bladder injuries
6	70	Male	Dislocation	Left	Accident	Right ankle fx dx
7	30	Female	Fracture	Right	Accident	Femoral fx
8	27	Male	Dislocation	Left	Accident	Pubic fx dx
9	42	Male	Fracture-dislocation	Bilateral	Accident	Tibialfx
10	41	Male	Fracture	Right	Falling	Pubic fx Iliac fx L5 transvers process fx Abdominal injuries
11	27	Male	Fracture-dislocation	Right	Accident	Pubic fx dx Iliac fx
12	28	Male	Fracture-dislocation	Left	Accident	Pubic dx Abdominal injuries
13	32	Female	Fracture-dislocation	Bilateral	Accident	Pubic fx
14	24	Male	Dislocation	Bilateral	Accident	Femoral fx Pubic dx

*Fracture, ** Dislocation

Table 2. Postoperative characteristics of the patients enrolled in this study

Patient	Follow up (month)	Delay to operation (day)	Vertical displacement (mm)		Majeed score	Leg length discrepancy	Reduction quality (Displacement)	Complication
			Before*	after				
1	20	6	15	0	80	5≤	5≤	-
2	6	23	5	0	66	10	5≤	-
3	10	10	15	0	78	5≤	5≤	-
4	42	13	10	0	77	5≤	5≤	Infection
5	12	4	10	0	73	10	5≤	Infection
6	6	11	5	0	54	5≤	5≤	-
7	48	12	5	0	80	25	5≤	-
8	32	15	5	0	100	5≤	5≤	-
9	56	45	55	20	100	20	≥15	-
10	56	12	15	0	78	10	5≤	-
11	51	16	5	0	100	5≤	5≤	-
12	42	15	5	0	84	5≤	5≤	-
13	12	2	5	0	74	5≤	5≤	Infection
14	56	180	60	5≤	50	10	5≤	Hard ware failure

Table 3. Patient's return to work status

Working status	Frequency (%)
No regular work	1 (7)
Light work	1 (7)
Change of job	2 (14)
Same job, reduced performance	6 (42)
Same job, same performance	4 (28)

Discussion

In the past few decades, pelvis injuries frequency has risen to about 3-6%. Until the end of the 1970's, the majority of pelvis injuries were treated conservatively and most patients died. In this study, we have surveyed pelvic fracture treatment results by SPF technique in 14 patients with sacroiliac Joint Injuries.

SPF has many advantages like strong assembly which provides the possibility of immediate regain of sitting position and rapid restoration of full weight-bearing walking during the third week after the operation. In contrast to the original method which was defined for bilateral lesions, we used a unilateral approach to the sacroiliac joint. Therefore, we thought, some cases in the 14 consecutive patients have probably lower risk of post-operative infections. However, in a study by Saigal et al., 46 patients underwent unilateral and 26 bilateral iliac screw fixations with mean follow-up of 31 months. They found that 13% (n=6) of the unilateral and 7.7% (n=2) of bilateral cases developed postoperative infection ($P=0.70$) (17). Kuklo et al. found that bilateral iliac screws coupled with bilateral S1 screws provide excellent distal fixation for lumbosacral fusions with a high fusion rate (95.1%) in high-grade spondylolisthesis and long fusions to

the sacrum (18). According to the results, placing bilateral or unilateral pelvic screws does not seem to produce additional clinical benefits in all cases with pelvic injuries.

In this study, two 7-mm iliac screws were inserted through sacroiliac connectors were placed on a rod linking the two sacral screws. Although the use of two sacral or iliac screws provides more stability, the same result was obtained in milder lesions that were classified in the lower OTA classes and were treated by one screw. Also, while longer screws have been reported to have increased pullout strength, however, they do not seem to have any en vivo physiologic or functional benefit over shorter screws (19). Therefore, it seems that the OTA classification and surgeon's experience are the most important factors to choose a better method in using one or two screws (17).

To our best knowledge, there is no study on the association between the patient's age and the fixation results. In this study, the age range of patients was between 24 and 70 years, the quality of the reduction in all patients was perfect (except one patient). The only significant finding in older patients was a lower Majeed functional score which can be attributed to the short-term follow-up.

The delayed surgery for pelvic injuries is more challenging because the anatomy of the pelvis is altered and less recognizable (20). According to standard protocols, the acceptable delay for these patients is between 4 to 6 days. In this study the mean interval between trauma and fixation was considerably high (mean 11.5 days). In a study between 1996 and 2007, Lindahl et al. have treated 797 patients with pelvic ring and acetabular fractures operatively. In the study, 15 operations were delayed (between 22-42 days from injury) and 24 late (> 6 weeks from injury) reconstructions (20). It seems, even

with the surgeons tend to perform the operations as soon as possible, the associated injuries and emergency cares (such as repairing ruptured liver and unstable vital signs in some patients) can lead to a delay in the operations. However, we found that SPF techniques are applicable in delayed and late pelvic ring fracture cases.

Wound-related complications are relatively common after SPF due to thinness and poor blood supply of the soft tissue in the sacral area (5). We did not find such complications in this study. According to the results, SPF required a shorter surgical time, incurred less bleeding, and had a lower infection rate. In a study, Hoffman et al., reported fixation of pelvic ring rupture for 7 patients without neurological complications, non-union and mal-union (5). In a study by Lindahl et al., they have not reported deep wound infection among patients with delayed and late reconstructions of the pelvis (20).

In a study with reliable outcomes, Hoffman et al., reported their experience for 119 patients with sacral fracture treated with SPF method (5). They have noted persistent neurologic dysfunction in 15 out of 119 (12%) patients, while in this study we did not see neurological injuries in the cohort. Jones et al., retrospectively reviewed 15 patients with unstable sacral fractures treated with lumbopelvic fixation over 8 years. In their cohort, 7 of the 15 patients had persistent neurologic injuries. They have reported that neurologic injury was related to the particular fracture patterns (21). In a study Gibbons et al., evaluated the neurological findings in sacral spine injuries patients admitted over a 2-year period with the diagnosis of pelvic or sacral injury. They have reported that the possibility of neurological injuries is higher in vertical and transverse central canal fractures (22). Therefore, we suggest this difference in the prevalence of neurological injuries between the studies could be due to the fracture types.

Reduction quality was excellent in 13 patients with less than 5 mm permanent vertical displacement. The lower limb length discrepancy in our study was good similar to Hoffman et al (5). Screw loosening and loss of fixation were observed in only one case due to the lengthy delay and high level of displacement before surgery. Jones et al., have reported posterior reduction quality in 11 of 15 cases with less than 5 mm persistent displacement and four of 15 with 5 to 10 mm displacement. In their study, loss of fixation due to technical fault was reported only in one patient while greater pain was a result of prominent hardware. Keating et al., evaluated the efficacy of the use of iliosacral screw in pelvic vertical instability fixation in 38 patients (19). They have found screw loosening in 7 and non-union in 5 cases. In our study, complete fusion was obtained in all patients. There were only one case of hardware failure and no secondary displacement. Oh et al. have reported the outcomes of surgical sacroiliac joint fixation in patients with unstable pelvic ring injuries and reported bone union in all 16 patients (23). Sagi et al., examined the effects of the iliosacral screw fixation on the stability and motion of sacroiliac joint with and without anterior symphyseal plating in patients with vertical instability in the anterior and posterior pelvic ring (24). Without the symphyseal plate, an abnormal loading response was seen at the sacroiliac joint, producing paradoxical posterior translation and sagittal

plane rotation. The rotation forces through the sacroiliac joint were controlled with SPF technique. The iliosacral screws should be directed perpendicular to the sacroiliac joint, while the chondral surfaces are protected (21).

In the present study the mean Majeed score was calculated 78, while it was 93 in Hoffman et al study. This difference could be due to a lower quality of post-operative care in our study. They performed material removal surgery only for one patient. In our study, 6 out of 14 patients needed remove of the material. In a study Zhu et al., have evaluated the clinical application of a new less invasive ilioinguinal approach combined with a minimally invasive posterior approach technique in patients with unstable pelvic fractures. They reported the clinical outcome at one year was "excellent" in 29 patients and "good" in 8 patients (25). Overall, in this study, the quality of reduction and lower limb length discrepancy was more satisfying, while infectious complications of deep incisions and Majeed score were not significant.

It is difficult to measure indirect or economic costs of a pelvic injury. Chronic pain has been reported with less than 50% returning to previous work status. In this study, we have observed that majority of patients underwent SPF were able to return to work. Therefore, surgical expertise in treating sacroiliac injuries by SPF may reduce overall costs. Hoffman et al., reported that after that patients, 80 (70%) out of 119 patients with pelvic injuries who underwent SPF, returned to work, an additional seven (6%) patients returned to a different job as a result of injury and 20 (17%) were not able to return to any kind of work (5).

To our best knowledge, there are a few studies about efficacy of SPF in sacroiliac dislocation or fracture-dislocations. In this study, we have examined the efficacy of SPF in the sacroiliac injuries treatment. However, our survey presents some limitations. The cross-sectional nature along with relatively small sample size in our study does not allow conclusions of causality on the observed associations.

According to the results of this study, spinopelvic fixation is a safe and effective technique to sacroiliac injuries treatment. It is associated with rapid restoration of full weight-bearing walking, less systemic complications, better care, lower loss of reduction or loosening screws, and lower chance of mal-union.

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Mohammad R. Sobhan MD
Seyed Mohammad J. Abrisham MD
Shahid Sadoughi University of Medical Sciences, Shahid Sadoughi Hospital, Yazd, Iran

Mahmood Vakili MD
School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

Saeed Shirdel MD
Yazd University of Medical Sciences, Shahid Sadoughi Hospital, Yazd, Iran

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