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Clinical, Functional and Radiological Outcome of Spinoplevic Fixation in Patients with Vertically Unstable Pelvic Fractures: A Prospective Study of 40 Cases

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Abstract--- Background: *Vertically unstable pelvic ring fractures have significant impacts on patient's quality of life. Several techniques have been described for stabilizing posterior pelvic ring injuries especially those with vertical shear pattern. The current study has been designed to evaluate the method of spinopelvic fixation as a method of treatment of complex vertically unstable pelvic injuries.*

Methods: *Between 2014 and 2019, a total of 40 patients with vertically unstable pelvic fractures were treated by spinopelvic fixation at the National Bank Hospital which is a trauma center in Cairo, Egypt. Patients were seen in follow up, on average, for 12 months after surgery. Functional outcome was assessed using Majeed score. Radiological outcome was evaluated by Matta radiological scoring system.*

Results: *The injury was unilateral in 36 patients and bilateral in 4 patients. The mean Majeed score was 82.5/100. The mean Matta radiological score for evaluating postoperative reduction showed excellent reduction in most of patients. Screw prominence occurred in 32 patients (80%) but wound dehiscence and deep infection occurred in 5 (12.5%) and 2 (5%) patients respectively. 9 patients (22.5%) had preoperative neurological deficit of sciatic nerve distribution. 8 of them fully recovered their neurologic deficit within the follow up period.*

Conclusion: *In comminuted patterns of vertical shear pelvic fractures, spinopelvic fixation proved to be an effective means for obtaining a stable rigid fixation with accepted rate of complications compared to other fixation methods. Wound related problems were the commonest associated complications. However, spinopelvic fixation was the only applicable method in specific fractures specially comminuted sacral fractures with neurological deficit.*

Keywords--- *Pelvic Fracture, Sacral Fracture, Vertical Shear, Spinopelvic Fixation.*

I. INTRODUCTION

Significantly unstable pelvic fractures, particularly vertical shear patterns, as well as U-type variant sacral fracture patterns that create spinopelvic instability, require the addition of lumbopelvic fixation instead of using iliosacral screw alone. The surgical technique involves neurologic decompression as necessary and placement of stable fixation by connecting the unstable injured pelvic ring to an uninjured lumbar spine. Treatment of those severe injuries that require lumbopelvic fixation is usually challenging and requires active collaboration between

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spine and pelvic trauma surgeons.1). Spinopelvic fixation method can allow early partial to full weight bearing postoperatively.2) Unstable sacral fractures represent challenging injuries and often are accompanied by high mortality and morbidity due to nerve injuries and malunion.3,4)

With a resultant discontinuity between the cephalad axial spine and the caudad segment attached to the pelvis and lower limbs along with associated soft-tissue complications, these injuries are difficult to treat.5)The goal of surgical fixation in this technique is to reconstruct the spine-pelvic-junction to allow early weight-bearing and to facilitate nursing care.6). Various options of internal fixation for vertical shear pelvic fractures have been proposed in literature including percutaneous iliosacral screws, percutaneous spinopelvic fixation, transiliac bars, sacral rods and posterior reconstruction plates.7,8)None of these techniques can, however, provide an adequate fixation for early unrestricted weight-bearing or allow early mobilization of these patients. On the other hand, in certain types of pelvic fractures such as transverse fracture of the upper sacrum, or ‘‘suicidal jumper’s fracture’’ described by Roy-Camille, spinopelvic fixation is the treatment of choice that can achieve stable fixation and adequate decompression of neurological elements.9). Some authors have introduced the technique of triangular posterior osteosynthesis (TPO) which builds on the same hypothesis of spinopelvic fixation in treatment of vertically unstable pelvic fracture. Recent articles have confirmed good clinical results of this technique which is a bi-planar fixation that can counterbalance the forces on the posterior pelvic ring during unipodal stance, so as to allow early weight-bearing.10,11,12). Another introduced technique of spinoplevic fixation is the crab-shaped fixation (spinopelvic fixation with 2 iliac pedicular screws in each iliac bone and 2 transverse subcutaneous connecting rods” double-rod technique”) which obviously provides good reduction and even more rigid fixation than single rod technique.13). This study was conducted to monitor the outcome of spinopelvic fixation in terms of its effectiveness compared to other techniques and the associated complications encoutered with it.

II. PATIENTS AND METHODS

Forty patients with unstable vertical shear (VS) pelvic fractures (AO types C1, C2 and C3) who were managed by spinopelvic fixation were prospectively followed up during the period of January 2015 and January 2019 in one of the major trauma centers in Cairo. Their mean age was 34.9 years. 47.5% had associated injuries either skeletal fractures or abdomino-thoracic injuries. The same procedure with single-rod technique was done to all patients with only some technical differences for individual associated injuries such as adding anterior fixation to stabilize the symphysis pubis or fixation of associated acetabular fracture. In all patients, posterior ring fracture was tackled using posterior midline approach while the patient was in prone position. Soft tissue and paraspinal muscles were dissected subperiosteally, then sacral fracture was exposed carefully and bony fragments inside the sacral spinal canal were excised by a spine surgeon with meticulous protection of neural structures and dural sac. Two 4.5 mm cortical screws were placed in posterior superior iliac spine (PSIS) through iliac bone bilaterally and were used for reduction of the vertical displacement by pelvic reduction clamp. Once the reduction was satisfactory and checked under fluoroscopy, two long 7 or 8 mm pedicular screws were placed into the iliac bone bilaterally at PSIS just below the level of the previously placed cortical screws. The prominent bone bed of the screws was then nibbled by a rongeur to reduce the prominence of screw head below skin to reduce postoperative screw prominence. A

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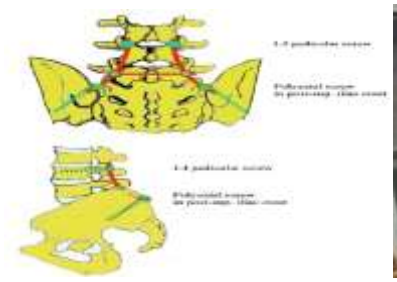
contoured 5 mm titanium rod was placed transversely to connect the pedicular screws. The 2 cortical screws were then removed and 2 pedicular screws were put in their tracks. Two molded titanium rods were used to connect the last inserted screws to the pedicular screws in L5 unilaterally or bilaterally to complete the construct assembly. In few cases, the transverse subcutaneous rod which connects the two PSIS was replaced by transiliac plate for reasons related to deficient hospital stock of large diameter (7 and 8 mm) pedicular screws. The technique of bilateral spinopelvic fixation is illustrated in Figure 1(1A) showing single rod technique, however unilateral L5 pedicular screw construct can be used in many cases.14)



(1A)

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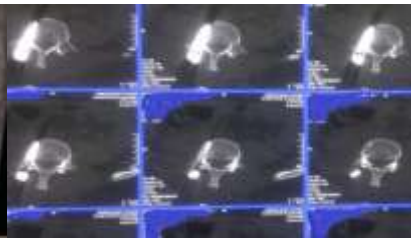

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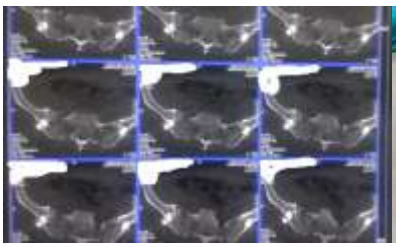

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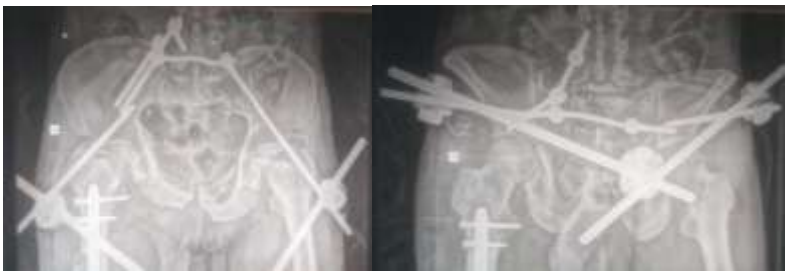

(4B) (4C)

Figure 1: Technique of Spinoplevic Fixation, Preoperative, Postoperative X-Rays and Clinical Photos of 1st Case

Nine patients (22.5%) had preoperative neurological deficit due to lumbosacral plexus injury however, 8 of them had full neurological recovery throughout the follow-up period.

Prominent screw was an issue recorded in 8 patients (20%), but only 5 patients (12.5%) experienced local wound complications. Two patients (5%) developed deep wound infection related to the implant and 5 patients (12.5%) required implant removal after 3-6 months postoperatively. Follow up was evaluated clinically and radiologically on each visit. Radiographic assessment of reduction was evaluated by Matta scoring system and clinical outcome was assessed in each visit by Majeed score.

III. OPERATIVE PROCEDURE

Two cases out of 40 were chosen to represent the technique. First case was AO type C1 pelvic fracture and associated comminuted femoral mid shaft fracture which was fixed earlier by retrograde nail. Preoperative plain x-rays are shown in Figure 1(2A, 2B and 2C). Symphyseal disruption was tackled first by symphyseal plate then posterior spinopelvic fixation was done in prone position in the same sitting Figure 1(3A, 3B, 3C, 3D, 3E, 3F and 3G). This patient developed postoperative sciatic nerve deficit but thankfully the neurological deficit totally recovered to grade 4 motor power scale after 4 months. He also developed subcutaneous abscess related to his anterior pfannenstiel incision and that was treated by 2 sessions of debridement and 4 weeks of parentral antibiotics based on the obtained culture and sensitivity. The wound discharge didn't improve so the symphyseal plate was removed after 4 weeks of index surgery and replaced by anterior supra acetabular external fixator Figure 1(4A, 4B and 4C). Overall Majeed score for this patient was 80 (good) and Matta radiological scale was excellent with fracture full union after 12 weeks.

Second case was AO type C3 pelvic fracture associated with comminuted sacral fracture Figure 2(5A, 5B, 5C, 5D, 5E, 5F, 5G and 5H). This was treated also with anterior symphyseal plate and posterior spinopelvic fixation but this time the surgeon decided to use transiliac transverse plating rather than the transverse rod due to unavailability of required size of pedicular screw (8 mm) Figure 3(6A, 6B, 6C and 6D). The patient developed postoperative wound dehiscence in the posterior wound related to the prominent screws Figure 3(7A and 7B) and that was treated successfully by Vacuum assisted closure (VAC therapy) Figure 3(8A and 8B). His Majeed score was 76 (good) and Matta radiological scale was excellent. His fracture was fully united after 12 weeks Figure 3(9).

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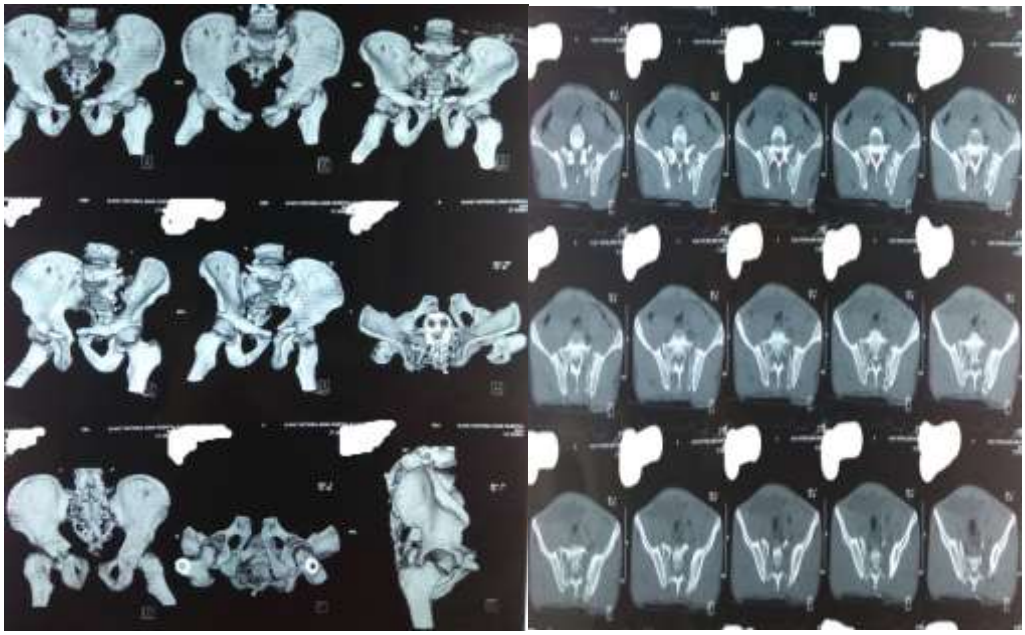
(5A) (5B) (5C)

(5D) (5E) (5F)



(5G) (5H)

Figure 2: Preoperative X-Rays and CT of 2nd Case

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(6A) (6B) (6C)

(6D) (7A) (7B)

(8A) (8B) (9)

Figure 3: Intraoperative Fluoroscopic Images, Early Postoperative and 12 Weeks Follow Up Images.

IV. RESULTS

The forty patients were followed up for 12 months (average 10.875 months). In the 9 patients who had preoperative neurological injury, gradual recovery was observed and full neurologic recovery was obtained through the follow up in 8 patients. One patient didn't regain his ankle and big toe dorsiflexion (L4 & L5 roots) and was not clear whether it was secondary to the initial trauma or due to an additional iatrogenic nerve injury during

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decompression of sacral canal. Average postoperative Majeed score for all patients was 82.55 (range 70-90). According to Matta radiological scoring of reduction, 33 patients (82.5%) had excellent fracture reduction, 5 (12.5%) was good and 2 (5%) was fair reduction. None of the patients lost fracture reduction or had implant failure throughout the study. Complete union of fractures took 2 to 4 months (average 2.6 months). Material prominence was observed in 8 patients (20%) and 5 of them (12.5%) developed wound complications and subsequently required implant removal within 3 to 6 months post operatively. Operative data and postoperative outcome in terms of functional outcome and postoperative complications are shown in Table 1. Final Functional assessment by Majeed score for all patients and its correlation to different variables are presented in Table 2. Rate of wound complications and the influence of each variable on this complication are demonstrated in Table 3.

Table 1: Operative Data and Postoperative Outcome

Variable(no.=40		No.	%
Majeed score	**Mean ±SD; (range)**	**82.55±4.86; (70-90)**	
Follow up months	**Mean ±SD; (range)**	**10.875±1.47; (9-12)**	
Postoperative neurological deficit	**No**	**31**	**77.5**
	Yes	**9**	**22.5**
Neurology improved on follow up (no.=9)	**No**	**1**	
	Yes	**8**	
Wound complications	**No**	**35**	**87.5**
	Yes	**5**	**12.5**
Loss of reduction	**No**	**40.0**	**100.0**
	Yes	**0**	**0.00**
Fracture union (months)	**Mean ±SD; (range)**	**2.6±0.61; (2-4)**	

SD: Standard Deviation

Table 2: Variations in Majeed Score According to Different Variables

Variable		No.	Majeed score		Test	P
			Mean ±SD	Range		
Age (years)	**18-25**	**9**	**82.78±5.29**	**72-90**	**KW=0.76**	**0.86**
	25-35	**12**	**82.08±4.27**	**75-88**		
	35-45	**8**	**83.75±5.55**	**77-90**		
	45-55	**11**	**82±5.14**	**70-88**		
Sex	**Females**	**18**	**84.94±3.5**	**80-90**	**MW=2.73**	**0.006 (S)**
	Males	**22**	**80.59±5.0**	**70-88**		
Tile fracture type	**C1**	**32**	**83.44±4.61**	**70-90**	**KW=5.49**	**0.06**
	C2	**4**	**79.5±5.97**	**72-86**		
	C3	**4**	**78.5±3.11**	**76-83**		
Preoperative neurological injury	**No**	**31**	**84.26±3.6**	**77-90**	**MW=3.78**	**<0.001 (HS)**
	Yes	**9**	**76.67±4.03**	**70-82**		
Postoperative neurological deficit	**No**	**31**	**84.26±3.6**	**77-90**	**MW=3.78**	**<0.001 (HS)**
	Yes	**9**	**76.67±4.03**	**70-82**		
Wound complications	**No**	**35**	**83±5**	**70-90**	**MW=1.99**	**0.046 (S)**
	Yes	**5**	**79.4±1.95**	**76-81**		
Deep infection	**No**	**38**	**82.68±4.95**	**70-90**	**MW=1.12**	**0.26**
	Yes	**2**	**80±0**	**80**		
Matta radiological scoring	**Excellent**	**33**	**82.64±4.88**	**70-90**	**KW=1.28**	**0.53**
	Good	**5**	**83±6.04**	**75-90**		
	Fair	**2**	**80±0**	**80**		
Implant removal after 3-6 moths	**No**	**35**	**82.6±4.98**	**70-90**	**MW=0.53**	**0.59**
	Yes	**5**	**82.2±4.38**	**80-90**		

SD: Standard Deviation P: Probability MW: Mann-Whitney test

KW: Kruskal Wallis test S: Significant difference (P<0.05)

HS: Highly Significant (P<0.001)

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Table 3: Rate of Wound Complications According to Different Variables

Variable		Wound complications				P*
		No (no.=35)		Yes (no.=5)		
		No.	%	No.	%	
Age (years)	18-25	7	20.0	2	40.0	0.65
	25-35	10	28.57	2	40.0	
	35-45	8	22.86	0	0.0	
	45-55	10	28.57	1	20.0	
Sex	Females	17	48.57	1	20.0	0.35
	Males	18	51.43	4	80.0	
Preoperative neurological injury	No	27	77.14	4	80.0	1.00
	Yes	8	22.86	1	20.0	
Delay to surgery (days)	1-7	21	60.0	3	60.0	0.13
	7-14	10	28.57	0	0.0	
	14-21	4	11.43	2	40.0	
Deep infection	No	35	100.0	3	60.0	0.01 (S)
	Yes	0	0.0	2	40.0	
Implant removal after 3-6 moths	No	34	97.14	1	20.0	<0.001 (HS)
	Yes	1	2.86	4	80.0	

*Fisher Exact Test P: Probability

S: Significant difference (P<0.05) HS: Highly Significant (P<0.001)

V. DISCUSSION

Pelvic fractures are serious injuries associated with a diverse assortment of morbidities. 15) Posterior fixation using a rod and screws system is suitable for treatment of vertical shear fractures. The fracture is reduced by limb traction in prone position and using pedicular screws construct.16)

Wound related complications are relatively common after spinopelvic fixation.17) In our study, 9 patients encountered material prominence, however only 5 of them developed wound related complications and out of those only 2 patients had deep wound infections related the metal work. They were treated by serial debridement, lavage and local wound care but, eventually, the 5 patients who had wound complications ended up by removing the implants within 3 to 6 months after surgery.

In the past, complex vertically unstable pelvic fractures especially those associated with transverse sacral fractures were often undiagnosed leading to development of neurological deficit. Even if diagnosed, those fracture patterns were treated conservatively due to absence of satisfactory surgical technique for treatment.3,18)

In a review of 50 patients who underwent percutaneous iliosacral screw in another stydy, Jonneti et al, reported 7 iatrogenic nerve injuries.7) In our study, 9 patients had preoperative neurological deficit but, 8 of them improved to full recovery during the follow up period.

In another study carried out by Pearson et al, Thirty-one spinopelvic dissociations were surgically managed (15 patients were treated with open and 16 with percutaneous techniques). It was evident that percutaneous spinoplevic fixation was associated with significantly less blood loss. However, treatment outcomes in terms of infection, length of stay, operative cost, and final bony alignment between the open and percutaneous group were similar.

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VI. CONCLUSION

In conclusion, we found out that spinopelvic fixation is a convenient and reliable procedure for treatment of complex vertically unstable scaral and pelvic fractures. However, local wound complications might be a frequently encountered complication that often necessitates early hardware removal shortly after reaching full fracture union.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

Ethical Approval

This study was approved by the institutional ethics and Research committee in Benha faculty of medicine.

Consent for Participation and Publication

The patients received an explanation of the procedures and possible risks of the surgery, and gave written informed consent. All the patients in this study have given their informed consent for the article to be published.

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The authors declare that sponsors had no such involvement.

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