



Percutaneous iliosacral screw fixation in vertically unstable pelvic injuries, a refined conventional method

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Percutaneous ilio-sacral screw fixation is a well-established method for fixation of unstable posterior pelvic lesions. Due to unavailability of the navigation system in our institute and the limits of using CT-guided method, we tried to refine the conventional method. Between March 2011 and Nov. 2012, twenty patients with closed vertical pelvic injuries were admitted. They were 17 males and three females with an average age of 34 years (range from 27 to 55). Percutaneous ilio-sacral screw fixation was done in the supine position using a Schanz screw marking of a *fixed* entry point in the outer iliac table. Closed reduction was done in all cases with excellent reduction in 14 cases, good in two and fair in four cases. The mean duration of screw insertion was 17 minutes (ranged from 10 to 25). One case of injury of the superior gluteal vessels was present and one case with misplacement through the ventral part of contra-lateral sacral ala. No neurological complications were detected. Ilio-sacral screw fixation by this refined technique allows safe stabilization of vertical pelvic lesions with an acceptable complication rate.

Keywords : ilio-sacral ; vertical shear ; pelvic fracture.

INTRODUCTION

Injuries of the pelvic ring are uncommon injuries occurring in 3 to 8.2% of all trauma patients (6,15,23). Unstable injuries account for 46% of the pelvic trauma that result from high energy trauma and usu-

ally associated with other skeletal injuries (24). Vertically unstable injuries account for 5% of all pelvic injuries according to Young and Burgess and as a part of combined injuries in 10-15% of pelvic fractures (9).

The treatment of unstable pelvic injuries aims to obtain accurate reduction with mechanically stable fixation to achieve early ambulation (14,16).

The recommended method of treatment of vertically unstable pelvic injuries is combined anterior and posterior fixation of the pelvic ring. Closed reduction and percutaneous sacroiliac screw fixation of the posterior pelvic ring injuries was first described by Matta and then Routt. It has many advantages as compared to open techniques including minimal soft tissue disruption and limited blood loss, and lowered infection rates (14,16,22) and these advantages make it increasingly popular (21).

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However, there are some reported complications of this technique include hardware failure, misplaced screws, nerve injury, and poor posterior pelvic reductions (18).

We presented our experience in using ilio-sacral screw fixation in a simplified technique with the reporting of the possible complications.

In this study ; 1) All the patients gave the informed consent before being included into the study ; 2) The study was authorized by the local ethical committee and was done in accordance with the Ethical standards of the 1964 Declaration of Helsinki as revised in 2000.

MATERIALS AND METHODS

Between March 2011 and Nov. 2012 ; 20 patients were presented with vertically unstable pelvic injuries. They were 17 males and three females with the average of 34 years (ranged from 27-55 years). The mode of injury was, motor car accident in eleven cases, fall from a height in seven cases and motor bike accidents in two cases. Associated injuries were detected in six cases ; with a minimally displaced acetabular fracture in two cases, displaced calcaneus fractures in three cases, tibial fracture in one case and lumbosacral plexus injury in one case with internal hemipelvectomy. After stabilization of the patient's vital signs ; radiographic evaluation was done and includes anterior-posterior (A/P), inlet and outlet X-ray pelvic views and pelvic CT scan. The selection of this group was submitted to the following criteria :

Inclusion criteria : traumatic vertically unstable pelvic injuries that involved vertical sacral fractures, fracture dislocation through the sacrum, sacroiliac dislocation, combined anterior-posterior and vertical pelvic injuries, less than 2 weeks after injury and open injuries.

Exclusion criteria : insufficiency pelvic fractures, lateral compression fracture (compression fracture of the sacrum), transverse and H-shaped sacral fractures, crescent iliac fracture, trans-iliac vertical fractures, sacral dysmorphism and more than 2 weeks after injury.

According to the Tile classification (24) all cases were unilateral vertical injury (Type C1) with four cases of sacroiliac dislocation (Type C1-2 a2) and six cases of fracture-dislocation (Type C1-2a1) and ten cases of sacral fracture (C1-3). Sacral fractures were classified according to the Denis classification (3) with three cases of the Denis type 1, seven case of the type 2, and no cases of the type 3.

Surgical technique

Once the patient's general condition permitted, the operation was done. A full description of the method of fixation with the possibility of an intraoperative change to an open approach was given to the patient.

Under general anaesthesia, the patient was positioned supine on a radiolucent operating table. Single C-arm fluoroscopy was used to visualize anterior-posterior, inlet and outlet views. Insertion of external fixator pins (iliac crest or supra-acetabular) was done and reduction was progressing in a stepped manner ; longitudinal traction through ipsilateral limb (to correct vertical displacement), forward pulling of the iliac table through the fixator pins (to correct posterior displacement) and internal rotation of the pelvis (to correct anterior-posterior compression). The three pelvic views were used to assess reduction. After satisfactory reduction was obtained, tightening of the fixator clamps was done to maintain the reduction. Assessment of the reduction of the anterior part of the pelvic injury was checked and addition of anterior symphyseal plating was done in seven cases (Fig. 1). In the rest of the cases, the use of external fixator was sufficient.

The true lateral sacral view was then obtained to ensure the reduction and define the entry point for screw insertion as mentioned by Routt *et al* (16). A stab wound was made close to the iliac cortical density (ICD). Blunt dissection by a straight artery forceps was made to dissect a path for the subsequent steps. The set of instrumentation needed to insert the screw were 6 mm Schanz screw, 4.5 mm cannulated screw driver, bayonet-tipped K-wire, and a 4.5 mm cannulated drill bit (Fig. 2).

A 6 mm Schanz screw was passed through the stab wound till it abuts the outer iliac cortex caudal to ICD and cephalad to the 1st sacral disc space. The tip of the Schanz screw was adjusted in the proposed area similar to the freehand technique during the insertion of the distal locking screws of an intra-medullary nail (Fig. 3).

The Schanz screw was then tapped with a hammer for 1 cm to make the fixed entry hole in the iliac table (Fig. 4). The tip of a 4.5 cannulated screw driver (22.5 cm length) was inserted in the iliac table hole and settled well (Fig. 5).

The screw driver was firmly held against this hole without missing this point during switching to the other three pelvic views (A/P, outlet and inlet views).

A bayonet-tipped K-wire (1.8 mm width -37 cm length) was then passed through the cannulated screw driver till it abut the iliac cortex (Fig. 6).

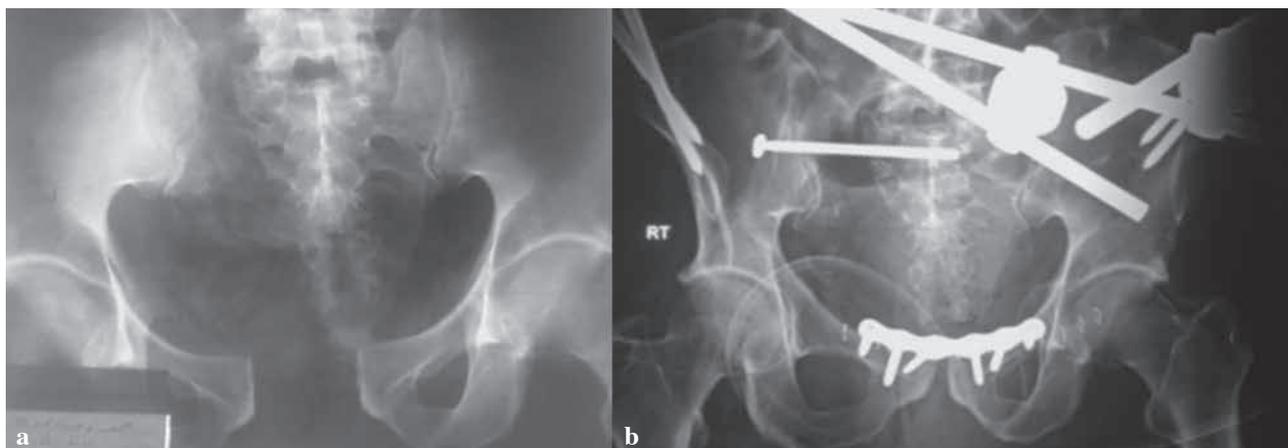


Fig. 1. — A case of vertical shear pelvic injury that was fixed anteriorly by combined plating and iliac fixator and posteriorly by SI screw.

- a) Pre-operative antero-posterior X-ray.
b) Post-operative antero- posterior X-ray.

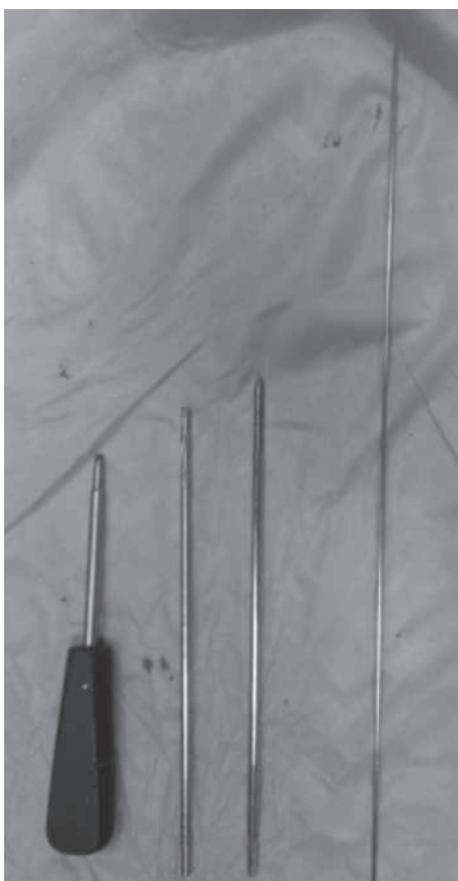


Fig. 2. — Instrumentation set from left to right ; bayonet K-wire, Schanz screw, cannulated drill bit, cannulated screw driver.

Drilling of the K-wire was guided by the three pelvic views. The screw driver was used to *manipulate* the direction of the wire that allows upward and downward tuning in the outlet view and forward and backward tuning in the inlet view in a way similar to the motion of arthroscopic instruments through the knee portals. Tuning of the screw driver was aided by sequential guidance of the C-arm. The passage of the wire was bounded by the radiographic markers for the first sacral body (S1 body) that are ; S1 foramen inferiorly and L5-S1 intervertebral disc superiorly in outlet view, neural canal posteriorly and anterior cortex of S1 segment anteriorly in the inlet view. The orientation of the wire was perpendicular to the sacro-iliac joint in cases of sacro-iliac dislocation and horizontal in the cases of sacral fracture and fracture-dislocation (Fig. 7).

The desired screw length was short from the midline of the sacrum in the cases of dislocation and beyond the midline in the cases of fractures and fracture-dislocation. After passage of the wire to the desired length, the screw driver was removed leaving the wire in its tract inside the bone. At this stage ; the screw length was detected by subtracting the part of the wire outside the bone from the length of an identical wire and the difference was equal to the screw length (Fig. 8).

A cannulated drill bit 4.5 mm was used and the drilling of the bone was guided by the three pelvic views to have the same orientation of the K-wire. A 7 mm cannulated screw with a washer was used for fixation (Fig. 9).

The stab wound was irrigated and closed, and post-operative X-ray pelvic views were taken as a reference during the follow-up.

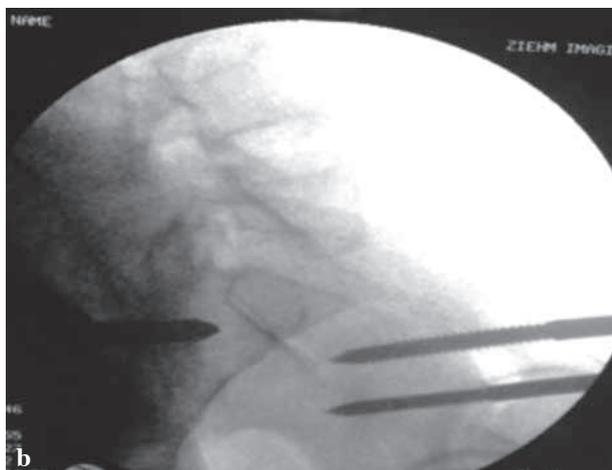


Fig. 3. — a) The tip of the cannulated screw driver is setted in the iliac table hole. b) Verification by X-ray.



Fig. 4. — Hammering of the Schanz screw



Fig. 5. — The tip of the cannulated screw driver is setted in the iliac table hole.

Post-operative care and follow-up

The position of the screw was confirmed using post-operative CT images. Reduction in the post-operative X-ray films was graded according to Matta and Tornetta (30) and the follow-up X-ray films (A/P, inlet, outlet) were taken at 6 weeks, 3 months, six months, one year, one and half years and two years. Weight bearing was not allowed for 6 weeks and partial weight bearing for another 6 weeks. Oral anticoagulation was given for 6 weeks (mini aspirin) till the removal of the external fixator. Intra-venous 3rd generation cephalosporins antibiotics were given for 3 days. At the end of the two years, the clinical scoring was done using the Majeed scoring system.

RESULTS

The mean duration of screw insertion was 17 minutes (ranged from 10-25 minutes). The longer durations were recorded at the start of our practice and in obese patients.

Intra-operative complications : Injury of the superficial division of the superior gluteal vessels was observed in one case during the insertion of the Schanz screw and the bleeding stopped with the packing of the wound with gauze soaked with saline/epinephrine mixture and no further intervention was needed suggesting that the injury affected a minute branch.



Fig. 6. — Passage of the K-wire through the cannulated screw driver.

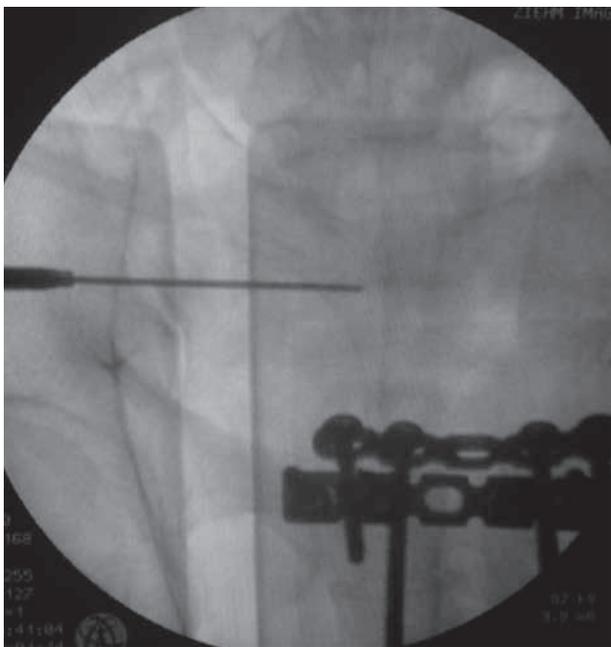


Fig. 7. — The position of the wire in the outlet view

Misplacement of the screw was observed in one case of fracture-dislocation with ventral protrusion of the screw in the contra-lateral sacral ala, but no neurological deficits were encountered. No cases of deep infection were detected.

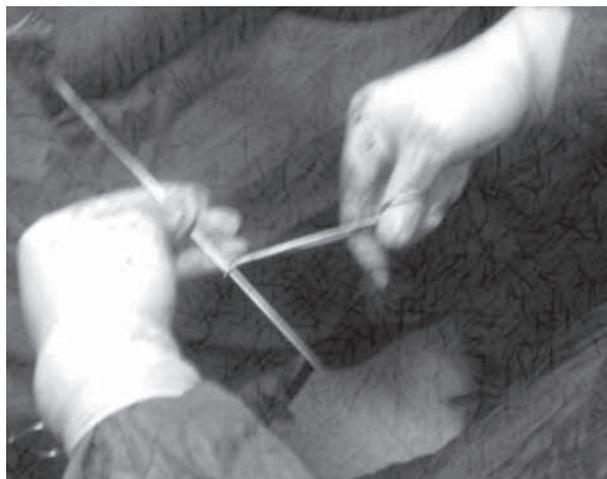


Fig. 8. — The difference in the length between the two K-wires in the length of part of the wire inside the bone which equals the required screw length.

Postoperative follow-up : Radiographic evaluation according to the Matta and Tornetta grading was excellent in 14 cases, good in two cases (5-10 mm displacement) and fair in four cases (10-20 mm displacement). No poor cases.

Clinical scoring by Majeed score at the end of the follow-up period was excellent in seven cases, good in ten cases, fair in two cases (two cases with sacroiliac fracture dislocation with residual displacement between 10-20 mm) and poor in one patient, this was a case of internal hemipelvectomy with a traumatic neurological deficit that was recorded at the time of admission.

DISCUSSION

Iliosacral screw fixation is a well-recognized technique for treating the unstable posterior pelvic lesion (17). The first report of an open screw fixation of a sacro-iliac dislocation was by Lehmann *et al* in 1934 (7). Open method carries a high complication rate in association with impaired wound healing and the reported incidence was as high as 25% in one series (12). These problems were avoided by the percutaneous methods. Percutaneous insertion of the screw in a prone position was popularized by Matta with the use of inlet and outlet fluoroscopic projections (14). Routh introduced the use of the supine

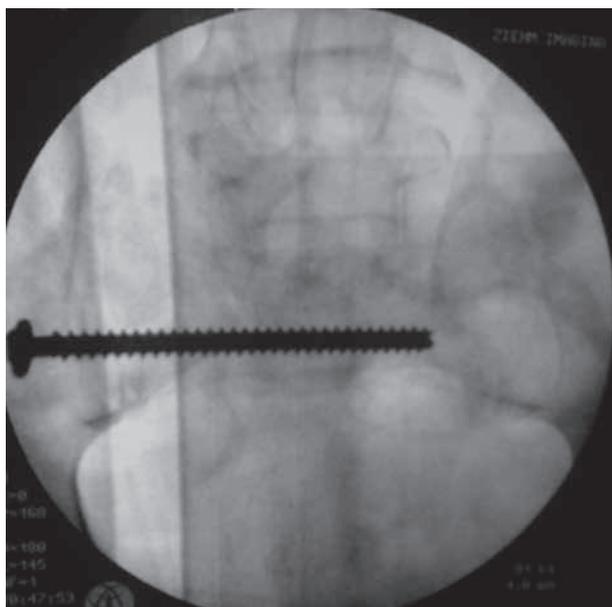


Fig. 9. — The final position after insertion of the screw

position with the use of lateral sacral view to add more accuracy of the screw insertion by 2D fluoroscopy (17).

The most severe complication is iatrogenic damage of the lumbosacral trunk and the S1 root due to extra-osseous pathway. This risk is increased in the presence of incomplete reduction of displaced fractures or dislocations (25). The risk of neurological injury after sacroiliac screw mal-position was estimated to lie between 0.5% and 7.7% of cases (27).

To avoid this extra-osseous trajectory ; several modifications were used besides the conventional fluoroscopy as Computer Tomography (CT) guided and computer assisted navigation guided techniques. Iliosacral screw insertion by using CT guidance is performed in CT radiology units (2,4,10,11,28). However, operating in the CT suite has its limitations. The patient is positioned prone or semi-lateral, which limits closed manipulative reduction. It is important that the reduction of the sacral fracture or sacroiliac joint dislocation is as accurate as possible and, if closed reduction fails, it is difficult to proceed to open reduction. Some conditions, as morbid obesity and previous use of bowel contrast make surgery, under CT guidance technique are more difficult. So, it is used only in selected group of

patients and when available resources are present (28). Another limitation is the use in emergency situations that cannot be done in CT assisted screw insertion (19).

Computer-assisted navigation for screw insertion showed better results than conventional fluoroscopy with limited radiological exposure (1,7,13,29).

Although these techniques promise superior results due to the improved quality of the imaging techniques, mal-positioning is still possible (11).

Comparative studies between conventional and navigation assisted methods were done (20,29,30). In a study, complete intra-osseous screw position was found in 42% of cases using the conventional technique and was significantly less compared with 81% using a navigation system with the revision rate of 1.6% in the navigated group compared with 19% in the conventional group (29). Another study found that, the fluoroscopy time was less in computer assisted surgery compared to conventional method, however, the study found no difference in complication rate (20).

In a more recent study, the rate of intraoperative complications was not significantly different, with 10/114 patients undergoing navigated techniques (8.8%) and 14/239 patients in the conventional group (5.9%) for percutaneous screw implantation (30).

Some reviews found that the surgeon's experience is an influential factor in the obtained results. Highly experienced surgeons give better results in both techniques (conventional and navigation) (1,8). Although the rate of misplacement was higher in conventional than navigated group (15% to 3%) in one review, the experience factor was clearly defined between the most experienced surgeon with malposition rate of 3.9% and low volume surgeon with malposition rate of 20%, a finding that cannot consolidate the malposition rate found in conventional group but supports that "In experienced hands, the use of navigation represents a helpful tool to improve the placement accuracy of iliosacral screw" (8).

Because some surgeons found the navigation system to be a time-consuming and costly procedure, they tried fluoroscopy-guided technique using a radiolucent drive designed for the distal locking of

the intramedullary nails and found a misplacement of screw in three out of 27 patients that is comparable to the conventional method (5).

Due to unavailability of the navigation system, we tried to modify the iliosacral screw insertion using the conventional method. Through a *fixed* entry point that was defined from the lateral sacral view, *tuning* the trajectory of the K-wire was done with a cannulated screw driver that was stuck to that entry point. The mean duration of screw insertion was 17 minutes (ranged from 10-25 minutes). The longer durations were recorded at the start of our practice and in obese patients. The misplacement rate was one of 20 screws and no re-operation was needed as no neurology was detected.

CONCLUSION

Inserting ilio-sacral screw using conventional fluoroscopy can be refined with this technique. The associated complications are within the reported rates. The limits of study are the low number of cases because vertically unstable pelvic injuries are not common form of trauma. Second, long-term functional results need a further study.

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