Original Article

The use of pedicle screws in stabilizing posterior pelvic ring fractures

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ABSTRACT

Purpose: In this study, the clinical, functional and radiological outcomes of the patients were evaluated using a pedicle screw/rod system technique in stabilizing the posterior pelvic ring fractures. Methods: This was a prospective study during the period of April 2013–January 2016 in the level 1 trauma center, and thirty-eight (38) patients underwent internal fixation for pelvic ring fractures using pedicle screws and rod technique. Out of these, twenty-four (24) were posterior pelvic ring fractures with or without anterior pelvic failure (6 cases with posterior pelvic fixation only, 7 cases fixed with anterior and posterior pedicle rod system technique, 11 cases fixed with posterior pedicle rod system and any sort of anterior pelvic ring fixation EF and/or symphyseal plate). The study group was comprised of 13 men and 11 women, with a mean age of 31 years (range 18–60 patients were followed up for a minimum of one year (12-17 months)). All patients were seriously injured and received a total-body CT scan at the time of emergency admission. Results Matta and Tornetta score was used to assess the radiological outcomes. There were thirty-eight cases in which the pelvic component of injury was managed operatively, the results were: 18 patients were excellent, 15 were good, and 5 had fare reductions. The Majeed score was used to evaluate the functional outcome of the patients, five factors were assessed and scored; pain, standing, sitting, sexual intercourse and work performance and the results for17 patients were excellent, 18 had good, 1 had fair and 1 had a poor functional outcome. Conclusion: Pedicle screw/rod system technique was a successful method for treating posterior pelvic ring disruption regarding the clinical and radiological outcomes. The reduction of sacral fracture was important to save satisfactory functional outcomes.

Keywords: Posterior pelvic ring fracture, Pedicular screw, rod system

Introduction

Pelvic injuries usually result from high energy, and life-threatening external forces as can occur following road traffic accidents or falls from a height.

The treatment of pelvic fractures needs an understanding of the injury and the pattern of instability. The major forces acting upon a hemi-pelvis are external rotation, internal rotation (compression from the lateral side) and vertical shear. External rotation is caused by a direct trauma on the posterior iliac spines or more commonly by forced external rotation of the lower limbs, and produces an open-book type of injury. An end point is reached when the posterior ilium abuts versus the sacrum, but if the power continues, the hemipelvis causes sheared off, resulting in gross instability. The internal rotation can be enabled by an immediate trauma on the lateral aspect of the hemipelvis or a vicarious power through the proximal femur. This starts by the failure of the symphysis pubis, and as the power continues, the failure of the anterior sacroiliac and sacrospinous ligaments occurs. This produces the failure of the symphysis or pubic rami anteriorly, and also the compression fractures of the posterior pelvic ring. The posterior and anterior pelvic ring disruption may happen either on the same side of the pelvis or on obverse side (bucket handle type). This latter type coincides with the main rotational deformities and may result in malunion. Due to the displacement of bone with the rupture of soft tissues, Vertical shearing power acts on the main trabecular pattern of the pelvis. In other scenarios, the rupture will occur, but in some instances, a lateral compression force may stop the rupture of the posterior elements.

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Generally, there is no end point to injury by this power, but a hazardous traumatic hemipelviectomy may occur [1].

The sacral fractures, sacroiliac joint and iliac wing fractures are the elements of posterior pelvic ring injuries. Sacral fractures especially comminuted V or H shaped fractures or even spinopelvic dissociation, are frequently displaced and unstable, and sometimes are associated with the neurological injuries.

The sacral reconstruction plate was one of the traditional methods for the fixation of these fractures with their complications especially the extensive soft tissue dissections and infection. Moreover, the fixation of sacral fractures by iliosacral screws is associated with the high rate of the loss of reduction and nonunion in addition to the risk of S1 nerve root injury [2].

Xiao-Tian Wu et al 2017[3]advocated a modern technique which consists of one or two iliac screws connected by a rod/rods. If the fractures were associated with the vertical instability, a vertical rod is added connecting iliac screws to the pedicle of L4 or L5 vertebra (Biplane internal fixator).

Material and Methods:

This was a prospective study during the period of April 2013 – January 2016 in level 1 trauma center, in which thirty-eight (38) patients underwent the internal fixation for pelvic ring fractures using pedicle screws and the rod technique. Out of those, twenty-four (24) patients were posterior pelvic ring fractures with or without anterior pelvic failure (6 cases with posterior pelvic fixation only, 7 cases fixed with anterior and posterior pedicle rod system technique, and 11 cases fixed with posterior pedicle rod system and any sort of the anterior pelvic ring fixation EF and/or symphyseal plate). The study group was comprised of 13 men and 11 women, with the mean age of 31 years (ranging from 18–60). The patients were followed up for a minimum of one year (12-17 months). All patients sustained high-energy trauma (in ten cases, the patients had fallen from heights of variable levels, nine cases were pedestrian of a road traffic accidents, three cases were involved in motor car accidents, one case was a victim of fall of wall on her back, and the last case was a Jet ski accident). In this study, the pelvic fractures were classified according to Tile classification [1]. Among the cases, 15 cases had an associated osseous injury, 4 patients had skin contusion around the pelvis with no open wound, and 2 cases had preoperative lumbosacral plexus injury. All patients were seriously injured, so, they received a total-body CT scan at the time of the emergency admission. Three of these cases who were haemodynamically unstable were managed with an external fixation in ER.

The surgery was performed after a mean time of 9 days (range 1–17) following trauma, once the patients were stabilized. In one of the three patients with type C pelvic injuries, the anterior external fixation was removed, and an anterior pelvic ring fixation was performed by plating the pubic rami and symphysis. In two cases, the external fixator was left in place until the fracture was healed.

Radiological investigations were consisted of AP, inlet and outlet views performed during the immediate postoperative period, and an AP view at the follow-up visits. The residual post-operative displacement and the late displacement of the posterior pelvis or fracture were measured by an independent observer. Failure was defined as at least 1 cm of combined vertical displacement of the posterior pelvis or fracture compared with the immediate post-operative X-ray.

Inclusion criteria:

1. Patients aging from 16-60 years old with the posterior pelvic ring fracture.
2. **Trans sacral internal fixator:** unilateral or bilateral comminuted (not impacted) sacral fractures with the fracture line pass medial with the intact L5/S1 facet joint
3. **Biplane posterior internal fixator**: unilateral vertical unstable comminuted sacral fractures (with lateral line fracture or a disrupted L5/S1 facet joint).
4. **Spino pelvic fixation**: Bilateral, vertical, unstable comminuted sacral fractures of H shape, V shape or Y shape fracture sacrum (with fracture line pass lateral and or disrupted L5/S1 facet joint.

Our exclusion criteria:

1) Patients outside the age range of 16-60 years old.
2) Non traumatic pelvic ring instability: e.g. tumors
3) Stable pelvic ring fracture.
4) Pregnancy.
5) Sacroiliac joint disruption.

Operative procedure:

- **Anesthesia:**

General anesthesia was used for all the patients, and was combined with the epidural anesthesia in some of the cases for postoperative pain control. Prophylactic broad-spectrum antibiotic, 3rd generation cephalosporine, was given preoperatively within an hour, and a urethral catheter was introduced before surgery in all the cases.

- **Patient positioning:**

While Patients were in prone position, the radioluscent area was ensured under the pelvis allowing for later intra-operative fluoroscopic AP, inlet and outlet views.

- **Approaches:**

Closed approach:

A small opening was made on both PSIS about 3-4 cm.

Open approach:

-A midline direct sacral approach was achieved by midline incision of 10 cm from PSIS. The subcutaneous tissue and fascia was opened using the diathermy; the muscle was stripped by the cup or using diathermy lateral to posterior sacroiliac joint and PSIS. Self-retaining was used side by side to avoid the excessive soft tissue trauma and traction (Figure. 2).

After a proper homeostasis, a sharp awel was used as a starter, and a pedicle finder or a power drill was used to make a hole for pedicle screws in both sides in 30 degrees caudal and 40 degrees lateral trajectory.

After that, a feeler was used to measure the depth and the position of the screws using the C- arm. Trimming Some of PSISs were trimmed by a bone rongeur to make the screw less prominent. Appropriate pedicle screws were inserted usually at 70mm.7mm, and the positions were checked by C-arm again.

The reduction can be achieved by another temporary 4.5 mm screw in both PSIS and the pelvic clamp. Then, the rod was molded and inserted subcutaneously under the skin and subcutaneous tissues.

Figure :1A- Pre and postoperative antroposterior X-ray of spinopelvic fixation of an H shape sacral fracture. B- Pre and postoperative antroposterior X-ray of biplane internal fixator of vertical unstable sacral fracture.

Figure 2: Direct sacral approach & technique of the reduction in case of spinopelvic fixation and lumbopelvic fixation (biplane internal fixator)

In case of spinopelvic fixation and lumbopelvic fixation (biplane internal fixator); extending direct posterior sacral approach proximally exposing both sacrum and posterior spinal element for the insertion of pedicle L4 or L5 screws.

For L4 or L5 screws, the pars should have been exposed to interarticularis and transverse process of the targeted vertebrae. The entry points were the junctions between the transverse process and pars interarticularis in the 20 degrees convergent and 15 degrees caudal for L4, and 20 to 30 degrees for L5.

Results:

Post-operatively, the patients were checked for the condition of the wound, neurology, and distal pulses. The distal pulses were felt in all patients, and there were no intra operative iatrogenic neurologic injuries. Closed suction drains were removed after 2 days in all of the patients; and the patients were mobilized to a chair as soon as possible; most of them on the 2nd postoperative day. The sitting tolerance improved gradually during the first 6 weeks, and reached normal duration by 12 weeks. The cases were followed up for a minimum of 12 months (ranging from12 – 17 months), and two cases were lost in the follow up visits .

Matta and Tornetta score [4] was used to assess the radiological outcomes, and Majeed score [5] was utilized for the analysis of clinical outcomes starting from 6 months follow up.

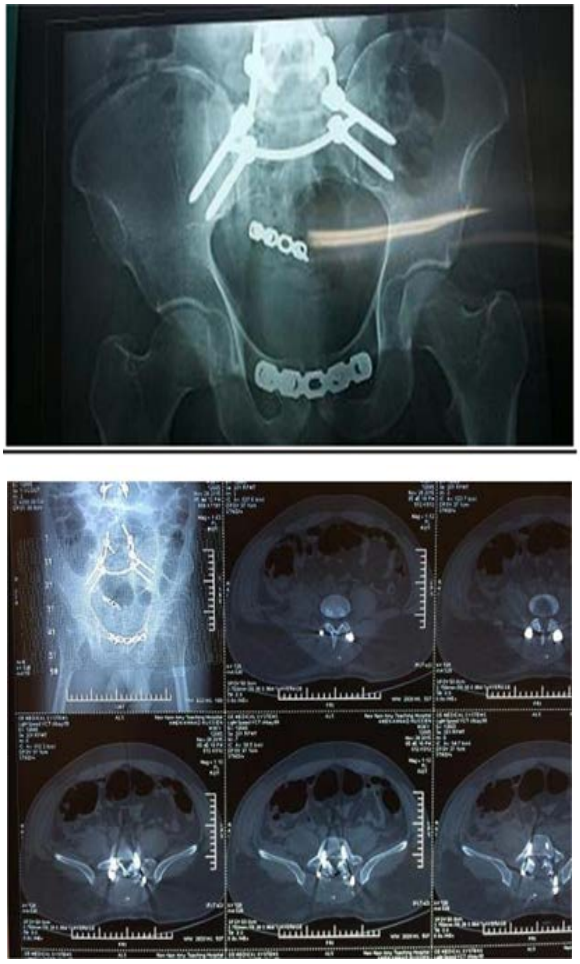

Figure3: Postoprative plain X ray and CT

Scoring of the results

The Majeed score was used to evaluate the functional outcome of the patients, five factors were assessed and scored including: pain, standing, sitting, sexual intercourse and work performance.

The mean of clinical outcome was better in those having excellent reduction. This emphasized the importance of the reduction of pelvic ring fracture to be reflected on patients' functional result.

Complications

- **A- Infection:**

Wound problem was recorded in 3 patients; 2 of them had a superficial wound infection with serious discharge, and one patient had deep wound infection with the purulent discharge

The 2 cases who had superficial wound infection were cases number 2 and number 20 (at direct sacral approach).

This infection was managed by repeated dressing and antibiotic treatment. All of them went to the uneventful recovery.

The heavily infected patient was the case number 16, who was managed by repeated dressing, antibiotic according to the culture and sensitivity repeated vigorous debridement (3 times) instruction to avoid sleeping on her back, the rotational flab, vacuum suction and finally ending a removal of hardware was needed to cure the wound.

- **B- Malreduction and malunion:**

In all the cases, it was aimed at anatomical reduction; the results of the series showed that 8 had excellent reduction (≤4mm) (33.36%), 11 had good reduction (4-10mm) (45.8%), and 5 had fair reduction (10-20mm) (20.8%).

The five cases in which fair reduction was achieved included; case number 2, which was managed more than 2 weaks post injury by trans sacral internal fixator on 3rd day postoperative where the revision was done by lumbopelvic fixation with the residual displacement about 2cm resulting in malunion, but still the patients' clinical score was good according to Majeed scoring.

The other case was case number 5, and she was thin, and treated by closed method fearing of metal prominent and wound problems, like cases number 11, 19 and 24.

- **C- Neurological complications;**

Preoperative;

- ✓ Lt lumbosacral plexus injury (case No. 6) was not improved till 9 month follow up.
- ✓ Rt lumbosacral plexus injury including urine and stool incontinent was improved postoperative but the foot droop was not improved on further follow up. (case20)

- **D- Miscellaneous complications:**

1. Pain at rods and screws sites: was one of the patients complaints especially in case number 9.

Discussion:

Posterior pelvic ring injuries occasionally involved the sacrum. Such sacral fractures were frequently comminuted, displaced and unstable, and might be associated with a neurologic insult. The reduction and stabilization of such fractures were difficult and complicated, and carried the risks of several iatrogenic complications.

The surgical management contained a wide spectrum of options from minimally invasive techniques to formal open lowering and internal confirmation.

Transiliac bars, posterior ilio-iliac plates, local plate fixation of sacral bone and iliosacral screws have been described [6]. In this study, pedicle screws and a rod system were used to connect the pelvis to the spine or reconstruct the posterior pelvic ring techniques acceptable for soon mobilization, while the mechanical and neurological state was stable. The open reduction was performed in 14 cases, and the closed percutaneous approach was done in 10 cases. The percentage of wound infection was 12.5% (3 cases); one case was closed, and 2 cases were open approach. The clinical outcome was related to the radiological reduction. This results were equal to Jan Lindahl et al 2014 [7]. They advocated that, the quality of reduction in terms of residual postoperative translational

displacement and kyphosis of the transverse sacral fracture were also connected with the clinical results.

The open reduction versus the closed reduction of sacral fractures depended on numerous factors related to the fracture itself and also the patient. The indication of open reduction included severe comminuted sacral fractures which needed bone graft and/or displaced fractures, or when the reduction by closed manner could not be achieved, the patient suffered from neurological deficit which needed neural canal or root decompression. Moreover, the associated soft tissue crush and devitalization, open wounds, or internal degloving (ie, Morel-Lavalle–type lesions) must have been dealt accurately before proceeding with this form of reduction and the fixation to avoid potentially devastating complications. For this reason, the patient might be in the prone position for long periods, and poor ventilator status might be a relative contraindication to proceeding with this method of fixation. Therefore, physiologic status and soft tissue conditions were patient agents that were very important in the decision-making process [8].

Routt et al. [9] showed that the delays of surgery of 5 days or more were related to poorer closed reduction rates.

Regarding the biomechanical stability, trans-iliac fixator (TSIF) was introduced as an alternative of ISS procedure in the fixation of comminuted transformational fractures. Though this technique proposed higher stiffness and lower stress with a lower risk of over-compression [10], it had its limitations including the failure of closed reduction and the questionable vertical stability.

In this study: TSIF was used in 11 cases, and no displacement occurred except in case number 7 due to the fracture line pass lateral to facet joint fixed with transacral internal fixator and cervical plate without any stability to fight vertical displacement of the sacral alar fragment and hemipelvis. The revision of this case was done, and the fixation was extended to L5 pedicle which is called lumbopelvic fixation or biplane internal fixator.

Lumbopelvic fixation (biplane internal fixator) was done in 9 cases, and when the sacral fractures were bilateral, H shape, U shape and V shape fractures spinopelvic fixation were done (3cases). No displacement occurred in the series in this study in both biplanes internal fixator orspinopelvic fixation.

The Biplane internal fixator or spinopelvic fixation was applied and the cephalad translation on the unstable hemipelvis was locked down to neutralize the deforming power of flexion, and external rotation.

Schildhauer et al. in (2003) [11] advocated that, in a cadaveric and biomechanical evaluation under the cyclic loads in unstable sacral fractures, the fractures of the posterior pelvic ring were fixated with different techniques (transiliac plate osteosynthesis, sacroiliac screw osteosynthesis, transiliac compression rods, and local plate osteosynthesis), and were uniformly less stable than the intact pelvis. There was not any considerable initial stability in the instant postoperative period among the constructs, which would permit the earlier full weight bearing and earlier return to the normal activities once a day. Therefore, a more recently described operative stabilization technique using biplane internal fixation was advantageous; and it provided a higher degree of stability. The advocates of these fixation techniques recommended similar postoperative rehabilitation programs with 6–12 weeks of partial weight bearing on the injured hemipelvis and lower limb. However, in (2011) Dienstknecht et al. [12] said that the transiliac internal fixator provided the same biomechanical stability as iliosacral screws and ventral plate osteosynthesis in AO type C pelvic ring injuries (complete disruption of posterior arch with the vertical and rotational instability). They suggested the use of this device as an appropriate substitution to the other implants.

Conclusion:

Pedicle screw/rod system technique has been a successful method for treating posterior pelvic ring disruption regarding the clinical and radiological outcomes. The reduction of sacral fracture has been important to save satisfactory functional outcomes. Open versus closed reduction decision should be taken carefully and meticulously. **Soft tissue technique** decreased the incidence of wound infection. However, careful pre-operative planning, and careful selection of **the fixation device** could help in minimizing the complications.

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