

# Pedicle screw-rod fixation and pelvic external fixation for the treatment of unstable pelvic ring fracture

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## Research Article

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# Abstract

**Background** Pelvic fracture is often associated with life-threatening damage and mechanical instability. Surgical therapy is a prior choice. To minimize surgical invasion and risk, bilateral screws combined with curved rod were applied to stabilize posterior pelvic ring. Anterior external fixation was to improve the fixation strength. This study was aim to explore the clinical effect of the procedure.

**Methods** From January 2018 to January 2020, 27 patients with posterior pelvic fracture were included retrospectively. There were 12 males and 15 females with an average age of  $56.3 \pm 14.2$  years. The prognosis of pelvis was evaluated by Matta and Majeed scores. Relevant clinical evaluation indications include the time of fracture healing, limb function and complications.

**Results** The average follow-up time was  $14.2 \pm 5.4$  month. Matta scoring standard: excellent in 18 cases, good in 7 cases, the good rate was 92.6%. The average healing time was 8.4 months. The standard of Majeed score in 6 months after operation: excellent in 14 cases, good in 10 cases, the good rate was 88.8%. At the last follow-up, the functional recovery of the affected limb was satisfactory. No deep infection occurred after operation.

**Conclusion** The results indicate that screw-rod system and external fixation is a safe technique. Minimally invasive technology reduced frequency of fluoroscopy. It provides a more simple and safety method for posterior pelvic fracture failed conservative treatment.

## Background

Unstable pelvic ring fracture is severe injuries, related with high-energy trauma [1]. Main causes are traffic accidents or falls from different heights [2]. High mortality and complication rates are associated with hemodynamic instability and mechanical malfunction of pelvic ring [3]. The predominant unstable fracture morphology involves posterior pelvic ring. Various treatments with reduction and fixation are aimed to reconstruct pelvic stabilization and enhance recovery. However, pelvic fracture especially posterior ring is difficult to restore because of complex anatomical structure and biomechanics. Long-term complications like postoperative pain, restricted activities, fixator loosen, bone nonunion and malunion are still a challenge for surgeons.

Minimal invasive technique with less operation time, as well as blood loss, has become more relevant [4,5]. The screw system was applied with a minimal incision instead of wide exposing. Apart from poor reduction of fracture, percutaneous technique is controlled with repeated fluoroscopic view [6]. It brings radiation sickness. The screw-rod method bridges the bilateral iliac region to overcome these disadvantages [7,8]. The anterior pelvic ring structure and the posterior ring structure account for 40 and 60 % of the stability of the entire pelvic ring, respectively. The loss of anterior pelvic ring increases in shear force and vertical tension on the sacroiliac joint [9]. We modified this technique by adding anterior pelvic external fixation to enhance fixation strength. If vertical displacement was happened, we added

lumbar pedicle screw. The purpose of this study was to evaluate the clinical effects of this modified screw-rod fixator and external fixation for treating unstable pelvic injuries.

## Materials And Methods

The present study was carried out from January 2018 to January 2020. A total of 27 patients with unstable pelvic ring fracture underwent both minimal invasive pedicle screw-rod fixation and anterior external fixation in our local department. The inclusion criteria were an age of >18 years old, hemodynamic stability that support patients tolerating surgery well. Patients with soft tissue defects, open fractures were excluded.

Every case was supervised by ECG monitoring. Vessel ultrasound was routinely performed to screen for vascular injury or venous thrombosis. For patients over 60 years old, echocardiography was used to evaluate heart function. Anteroposterior, inlet and outlet pelvic radiographs were taken in all patients. Computed-tomography (CT) scan was further evaluated displaced fracture.

## Surgical procedures

The prone position was employed. The posterior superior iliac spine (PSIS) was marked. Bilateral 6 cm incisions were used 0.5 cm medially along the PSIS. Cortical bone was removed on the osseous entry point. The purpose was to prevent screw cap from soft tissue compression. The bone corridor was established toward the greater trochanter of femur by pedicle finder. The corridor was checked that we did not penetrate the ilium. Pedicle screws were maneuvered into the bilateral dorsal iliac crests. The pedicle screw with diameter of 6.5 mm and length of 65 mm was inserted. A titanium rod with 6 mm diameter was applied to connect the two screws. After adjusting the rod to the right place, the caps of pedicle screws were tightened. The screw positions and reduction was examined by fluoroscopy inlet and outlet views. A typical patient was showed in Fig 1. In case of vertical unstable fracture, patients were added lumbar fixation. The iliac screw was linked with lumbar pedicle screw (Fig 2). After being placed in supine position, the patient was managed by anterior pelvic external fixation. A 1cm incision was made below the anterior superior spine. Soft tissue was dissected to expose iliac crest. Two pins were inserted on each side of the pelvis. Before connected to the external fixation, pins were under fluoroscopic control.

## The postoperative rehabilitation

All patients were managed to start functional exercises of lower limbs without bearing from postoperative day 1. After acute pain period, patients were encouraged to take active and positive joint exercises. After 3 weeks, sitting was permitted by the patients. The anterior pelvic external fixation was removed 4 weeks after operations. The crutch-assisted walking was performed by the patients at 6 weeks postoperatively. Patients were allowed to gradually walking with full weight bearing when postoperative imaging

demonstrated bone union. Follow-up were ordered at 4 weeks, 8 weeks, 12 weeks, 16 weeks, 24 weeks, 9 months, 12 months, 15 months, 18 months postoperatively.

The radiological findings of pelvic ring were assessed by Matta criteria which measure maximal displacement by anteroposterior, inlet and outlet radiographs: excellent (<4mm), good (5-10mm), fair (11-20mm), poor (>20mm) [10]. The quality of clinical function was evaluated by Majeed criteria which include pain, sitting, standing, sexual intercourse and work. The overall score was 100. The full score was 80 while no score was obtained for work because of patients without work before operation [11].

## Results

There were twelve males and fifteen females, averaging  $56.3 \pm 14.2$  years old (range, 25-74). According to Tile classification, seventeen patients were diagnosed with type B and ten cases were type C. The results showed cerebral concussion in 3 cases, scalp laceration in 2, pulmonary contusion in 2, pneumothorax in 5, urethral injury in 5. The mean time to surgery was  $3.6 \pm 2.3$  days after admission. In this study, 10 cases were added lumbar pedicle screw. The operation took an average of  $2.6 \pm 1.7$  hours. The mean blood loss volume was  $200.0 \pm 66.7$  ml in type B and  $264.3 \pm 85.2$  ml in type C respectively. The severity of pain before surgery was  $7.5 \pm 1.2$  according to the VAS. A week after surgery, the pain was relieved to  $2.8 \pm 0.7$ .

In this study, no case was developed incision infection. Superficial exudation is more in 1 patient. No bacteria were found in secretion culture. The wound was delayed one month after operation. 1 patient experienced sensory disturbance of affected limb.

All patients were available for followed up. The mean time was  $14.2 \pm 5.4$  months. During the follow-up period, no delayed osseous union or nonunion was found from examination. The average time of bone healing was  $8.4 \pm 6.7$  months. Matta evaluation results were excellent in 18, good in 7, and fair in 1. Majeed evaluation scores were performed 6 months and 12 months postoperatively. The results showed excellent in 13, good in 10, fair in 3 at 6 months. It was excellent in 14, good in 10, fair in 2 at 12 months after operation.

## Discussion

Unstable pelvic fracture is the manifestation of pelvic ring destruction under direct or indirect violence which may be life-threatening [12]. It requires a careful and interdisciplinary decision-making regarding the therapeutic regime [2]. The principle of early diagnosis and treatment is to maintain hemodynamic stability. Potentially life-threatening bleedings can be detected early and thus leads to improve survival [13]. The examination of both lower extremity arteriovenous ultrasound was aimed to examine vascular injury, venous thrombosis [14]. In case of a polytraumatized patients, interdisciplinary team of general surgeon, radiologists, anesthesiologists should discuss which treatment is most urgent and whether damage control orthopedic surgery is indicated [15].

The treatment of pelvic fracture includes operation and conservative treatment [16]. Apart from causing pain and related immobilization, the dislocation of bone fracture affects the quality of life. Several surgical procedures have been introduced to ensure early ambulation. Internal fixation and external fixation have been frequently used [17]. To acquire better reduction of unstable pelvic fracture, a combination of anterior and posterior fixation is needed. A screw-rod system was reported to treat dorsal pelvic ring [18]. Compared to previous investigations, patient cohort and follow-up are outstanding characteristics. There are two small incisions to insert the fixation device. This fixator frame was formed firmly structure which restores posterior ring fracture. The biomechanical experiments of SAR et al show that this fixation mode can obtain satisfactory stability of the posterior pelvic ring [19]. The choice of incision should touch the posterior median line of iliac spine to facilitate screw placement and reduce the impact of soft tissue compression on screw placement direction. Partial bone resection of the PSIS at the entry point for settling the screw heads was preferred to minimize implant prominence and soft tissue irritation. During the follow-up, it was found that sacral screw implantation can relieve postoperative discomfort.

According to Tile, the anterior pelvic ring structure and the posterior ring structure account for 40 and 60 % of the stability of the entire pelvic ring, respectively, and the importance of the anterior pelvic ring should not be ignored [20]. External fixation has the characteristics of simple operation and light injury. However screw loosening, nail infection, insufficient fixation stability limit its application in pelvis [21]. In this mixed fixation group, there was no wound infection. The average follow-up period was 8.4 months. The excellent and good rate of Majeed was 88.2%. It did not increase the risk of bone nonunion and limb function limitation.

In recent years, several percutaneous techniques have been presented to treat pelvic fractures [22]. Though, the course of this method was controlled with fluoroscopic views repeatedly. Poor fracture reduction is also a limited factor. We found that our therapy will not increase the operative risk. Due to the various differences of pelvic structure, small incision can help surgeon judge the direction of iliac screw placement. The risk of penetrating the bone plate with damage of peripheral blood vessels, nerves or organs was declined. The lumbar screws were added to correct vertical dislocation.

Limitations need to be acknowledged. Firstly, this was a single-center retrospective study. More cases should be taken into account. Secondly, comparison with other methods was lack. If biomechanical analysis was added, the results would be more meaningful.

## **Conclusion**

Screw-rod fixator combined with anterior external fixation can afford pelvic ring fracture. The benefits include an easy to operate, low risk of nerve and vascular injuries, short operative time. This fixation could be an appropriate alternative method for unstable pelvic fractures.

## **Declarations**

## **Ethics approval and consent to participate**

This retrospective study was informed participants, their parents/legal guardians. The informed consent was obtained from all subjects and/or their legal guardian(s). We promised that data was applied for effective analysis alone, keeping individual information confidential. All methods have been performed in accordance with the Declaration of Helsinki and were approved by the Mianyang Central Hospital ethics committee.

## **Consent for publication**

Not applicable.

## **Availability of data and materials**

All data generated or analysed during this study are included in this published article.

## **Competing interests**

The authors declare that they have no competing interests.

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## **Authors' contributions**

JC as secondary surgeon made substantial contributions to conception and design, and acquisition of data. JH and TW is treating surgeon for cases involved. JH made substantial contributions to manuscript revising. DZ offered initial advice and acted as one of the reviewers. BS made substantial contributions to study design, drafting the manuscript and revising it critically for important intellectual content. NY was involved in the conception of the study improving it with important intellectual content. All authors read and approved the final manuscript.

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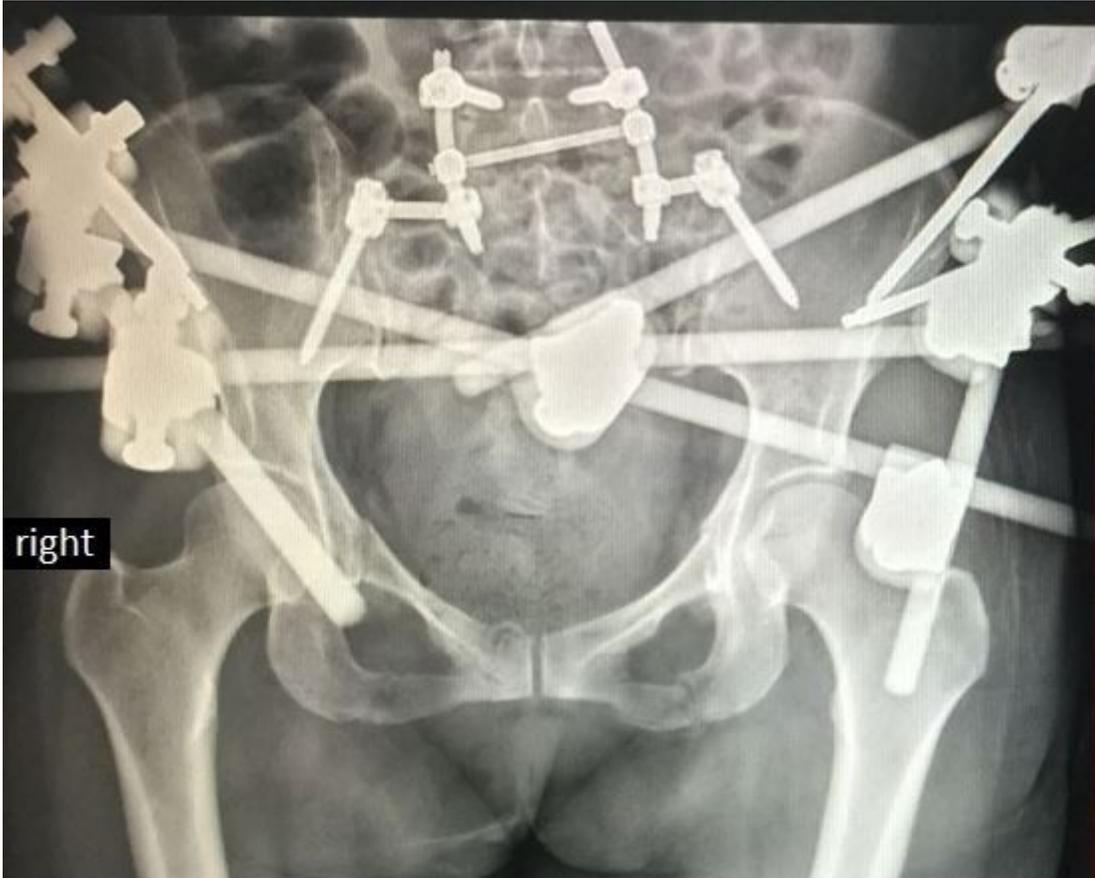
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## Figures



Figure 1

Posterior surgical incisions for screw-rod fixator (a). Postoperative plain X-ray showed anteroposterior appearance (b).



**Figure 2**

The lumbar screws were added to restore vertical stability.