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# Minimally Invasive Surgery (MIS) of Anterior Ring Fracture Combined with Pubic Symphysis Separation

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Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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**Background:** The aim of this study was to evaluate the reliability of open reduction and minimally invasive plate osteosynthesis (MIPO) for anterior ring fracture combined with pubic symphysis separation and to explore the operative techniques and therapeutic efficacy.

**Material/Methods:** We used minimally invasive plate osteosynthesis (MIPO) to treat anterior ring fracture combined with pubic symphysis separation.

**Results:** During postoperative follow-up, all patients recovered well, with no fat liquefaction, infection, femoral nerve or iliac blood vessels injury, deep vein thrombosis, heterotopic ossification, or any and other complications.

**Conclusions:** The MIS or MIPPO for anterior ring fracture combined with pubic symphysis separation has the advantages of short operation time and less blood loss. This clinical operation is safe and feasible, with therapeutic efficacy.

**MeSH Keywords:** Pelvic Bones • Pubic Symphysis • Surgical Procedures, Minimally Invasive

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## Background

The pelvis ligates the torso and lower extremities and its structural integrity is vital for its weightbearing function [1,2]. Pelvic fractures are common in severe orthopedic injuries [3,4]. Patients with unstable pelvic ring disruptions are considerably more challenging to treat. Functional outcome after these unstable pelvic fractures is affected by the presence of the severe bleeding, shock, and visceral injuries [5]. Furthermore, the outcome also is affected by development of malunion or nonunion of the pelvic ring, resulting from initial suboptimal reduction, insufficient fixation methods, and other local and systemic factors, resulting in chronic residual pain, deformity, and progressive functional disability. Early diagnosis and treatment can greatly reduce the mortality and morbidity [6].

With deepening understanding of the pelvic anatomy, early surgical intervention can be achieved, greatly reducing the morbidity and mortality rates of such fractures. However, there are important nerves, blood vessels, muscles, and other important tissues around the pelvis, and with the traditional surgical approach it is easy to damage these structures, leading to more complications in patients and exposing them to unnecessary financial and physical burden. During the last 2 decades, advances in imaging devices and orthopedic surgical techniques have greatly improved. Minimally invasive internal fixation, with its unique advantages such as percutaneous sacroiliac screw fixation and endoscopic anterior pelvic ring fixation, has become the development direction of pelvic fractures [7–10].

In this study, we used an exploratory, minimally invasive surgical approach for the treatment of pelvic fractures. By using experimental surgical procedures with human specimens, as well as post-operative clinical findings, the minimally invasive treatment of pelvic ring fractures and pubic separation can avoid injuring important nerves and blood vessels, which are important anatomical structures, to achieve the purpose of reducing the risk of surgical complications, and achieve good surgical results.

## Material and Methods

### General information

A total of 61 patients with orthopedic pelvic ring fractures in Third Xiangya Hospital were collected from 2010.01.01 to 2014.03.13. The patients received small-window minimally invasive surgery (group A) or conventional ilioinguinal treatment (group B), then a retrospective comparative study was conducted.

There were 23 cases in group A, including 16 males and 7 females; aged from 18 to 65 years, 4 injured by falling, and 19 people injured by traffic accident. Pelvic fractures were categorized according to the Tile classification, with 8 cases of Tile B type, 15 cases of Tile C type; 38 cases were included in Group B, with 26 males and 12 females; aged from 18 to 65 years, 7 cases hurt by falling, 31 people injured by traffic accident, Tile B type with 13 cases, and Tile C type with 25 cases according to Tile classification system. There were 29 patients with fracture of the pubic symphysis separation, and were divided into group C, who received minimally invasive surgical approach with a small window on both sides, and group D, who received conventional treatment through the abdominal rectus or white line. Seven cases were included in group C, aged from 18 to 65 years, 4 injured in a car accident, 2 cases by falling; 22 patients were included in group D, aged from 18 to 65 years, 8 people were injured in a car accident, 11 people were injured by falling; and there were 3 cases of postpartum injury.

### Surgical methods

Preoperative preparation: perfect correlation test was performed before surgery and abdominal ultrasonography was conducted to detect injury in abdominal organ and the cystography was used. When patient condition was stable, radiographs of anteroposterior pelvic inlet and outlet were obtained with CT scans and then 3-dimensional parallel reconstruction, catheterization, and enema cleansing were performed.

### Surgical procedure

Fixation of anterior pelvic ring fracture: preoperative skin preparation, routine disinfection, and intubation under general anesthesia were performed. Then acetabular reduction and fixation were applied. Manual reduction is used to reduce the anterior pelvic ring. A 3–4 cm curved incision was made in the position before the anterior superior iliac crest 2/3 and iliac spine, 0.5 cm above the inguinal ligament, followed by skin and subcutaneous tissue incision and muscle abdominal incision. With the use of periosteal stripping along the inside of the ilium subperiosteal, iliac and abdominal muscles were dissected starting at the iliac crest of the ilium through iliopubic uplift to the acetabular anterior column (first tunnel).

A 3-cm surgical incision was made in the nodules above the pubic tubercle. The skin and subcutaneous tissue was cut to isolate and protect the spermatic cord (or round ligament), revealing the suprapubic frontline (second tunnel) under the periosteum. With the limb hip flexor stretched, iliopsoas relax and the gap between hip psoas increase, 2 incisions were stripped to sneak in the anterior column acetabular periosteum phasor traffic (double-tunnel convergence technology), followed by reset and temporary fixation of fracture, pre-bent





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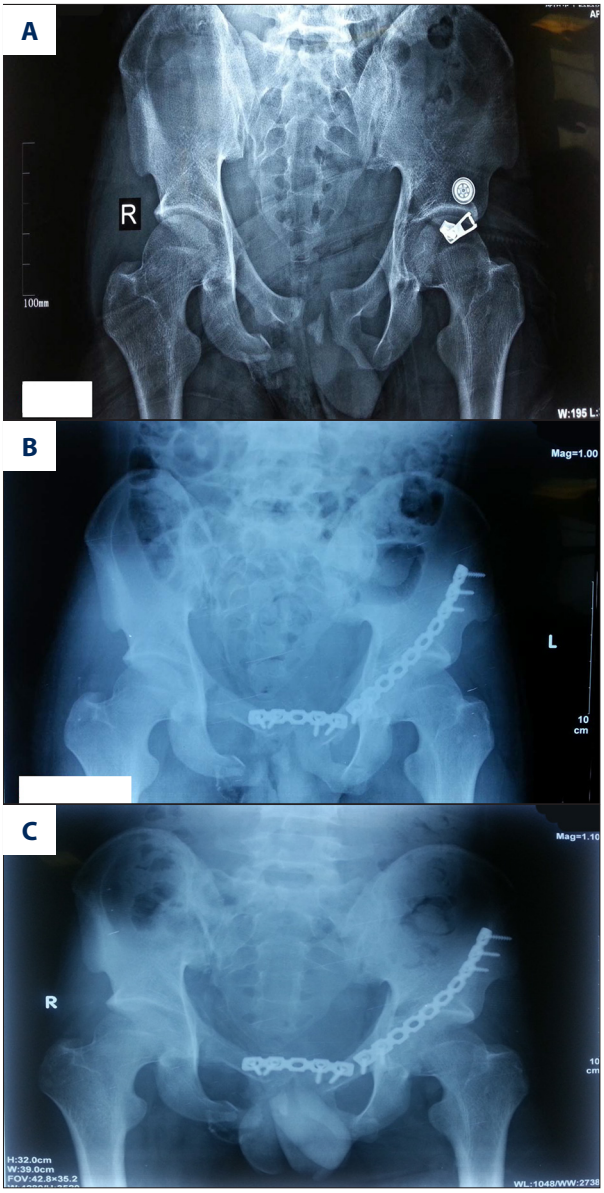


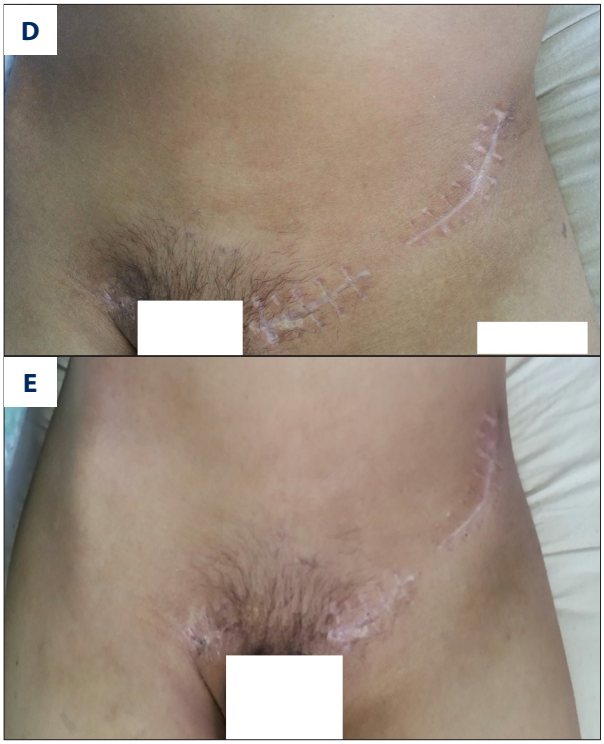


**Figure 1.** Pelvic ring fractures before the merger pubic symphysis separation. (**A**) Preoperative X-ray: pubic symphysis separation with pubic fractures of the right lower extremities; anterior column fracture of the left pelvis. (**B**) Postoperative X-ray after the second week: good reduction, no internal fixation loose and fracture. (**C**) Postoperative X-ray after the second month: callus formation at the fracture site, no internal fixation loose and fracture. (**D**) The wound condition after the first month postoperatively: dry wound, no signs of infection, and good healing. (**E**) The wound condition after the second month postoperatively: dry wound, no signs of infection, and good healing.

titanium reconstruction to import tunnels, front ring fracture fixation, placing a No. 20 drainage tube, repairing abdominal muscle tissue, and suturing the skin.

Pubic symphysis separation: preoperative skin preparation, conventional disinfection, anesthesia intubation, and bilateral supine were conducted. Then a 1.5-cm incision was made at both sides of the center of the pubic tubercle, followed by skin and subcutaneous tissue incision, muscle abdominal incision to expose the pubic tubercle, and subperiosteal dissection of the pubic symphysis at the 2 incisions, respectively (double-tunnel convergence technology). The bilateral sides of the pubic symphysis were fixed with a short screw, nuts, and some exposed thread, and then reset with the screw clamp. After good reduction of pubic symphysis separation with C arm fluoroscopy, a 5-hole reconstruction plate was fixed at the top of the pubic symphysis (Figure 1).

## Results

Traditional surgical approach and minimally invasive surgery both received satisfactory results in the treatment of anterior pelvic ring fractures and pubic symphysis separation reduction and fixation. In terms of operative time, group A (185.6 min) was significantly shorter than group B (235.4 min). In terms of incision length, group A was 8~12 cm and group B was 18~25 cm. In terms of intraoperative bleeding, group A had less blood loss, which was 350~450 ml in group A and 500~800 ml in group B. In terms of intraoperative complications, 2 cases in group A were obese and had postoperative swelling and mild fat liquefaction. After symptomatic medication, the wound





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healed and the patients had good recovery, and the remaining incisions were healing in phase I.

In group B, 3 cases had signs of fat liquefaction such as redness and exudate intraoperatively. With dressing change, the wound healed before hospital discharge. One case had a sinus at the incision 3 months after the operation, then sinus excision was conducted and the patient had a good recovery with a healed incision. One case had traumatic arthritis and osteonecrosis, then hip arthroplasty was conducted after 1 year and had a good recovery. Four patients had varying degrees of lateral thigh numbness and discomfort, but the symptoms improved after 6 months. The subjects in the 2 groups did not have intraoperative bleeding, severe nerve damage, deep venous thrombosis, inguinal hernia, long-lasting pain, or severe complications like lymphatic leakage.

For group C and D, the average operation time of group C was 127 min, while the time of group D was 149 min; the incision length for group C was 4–5 cm, which was shorter than that of group D (6–8 cm). In terms of bleeding, group C was 90–120 ml and group D was 150–200 ml. In group C, 1 patient had postoperative complications with fat liquefaction at the right side of the pubic symphysis incision, but no significant redness and swelling were observed, and the wound healed after medication change. In group D, 3 patients had wound swelling; 2 cases improved after dressing change, and 1 patient's wound healed after debridement. In the 2 groups, no inguinal hernia, femoral or iliac vessels nerve damage, or deep vein thrombosis were observed.

## Discussion

In the anatomy and biomechanics of the pelvis and anterior pelvic ring, the pelvic ring structure is made by the ligaments connecting the hip and sacrum [11]. The anterior pelvic ring had a 40% effect of stabilizing the pelvis. The posterior pelvic ring consists of the sacral ligament, sacrotuberous ligament, sacroiliac joints, and the ligaments around it and the stabilizing effect accounted for 60%. Research by Leighton has shown that normal pelvic structure forms a geometric invariant system that can maintain the original structure and morphology under strain [12]. Recently, with the in-depth study of biomechanics and anatomy, researchers have found that incomplete pelvic mechanics can lead to instability of the pelvis, and the stability of the anterior pelvic ring greatly affected the load and displacement of the posterior pelvic ring [13,14]. Therefore, the stabilization of the anterior pelvic ring and pubic joint separation is significant, not only for restoring normal pelvic anatomy and pelvic mechanical properties, but also for improving the clinical efficacy, and plays a positive role in improving late function.

Traditional surgical methods. (a) In pubic separation surgery, a curved incision is made above the pubic symphysis, followed by skin and subcutaneous tissue incision, dissociation of the spermatic cord retractor/uterine round ligament and ilioinguinal nerve, cut off the rectus sheath, the rectus muscle cone or abdominal surgery white line. Using this approach it is easy to damage vital tissues and has the possibility of creating a large postoperative ventral hernia [15]. (b) In anterior pelvic ring fractures traditional surgery treatment methods usually use an ilioinguinal approach, which was proposed by Letournel in the 1960s; the procedure can reveal the front and the inner side of the pelvis and acetabulum [16] and it is still a classic surgery approach. Many researchers found this approach had complicated surgical procedures and can cause trauma and complications, especially for middle-window groin separation operation, and are prone to injury of femoral nerve and iliac vessels, and postoperative deep vein thrombosis is extremely likely [17,18]. To avoid revealing the middle window so as to further reduce the incidence of trauma and complications of blood vessels and nerves, we used the ilioinguinal minimally invasive approach (double-tunnel convergence technology) for fracture reduction and fixation.

One of the advantages of minimally invasive surgical treatment of anterior pelvic ring injuries is that minimally invasive treatment is the inevitable trend of anterior pelvic ring surgery. Although the approach results in less damage to the patient to achieve the effect of fracture fixation, it has some issues that must be addressed. The intraoperative exposure and difficult operations require an expert surgeon [19]. Once operational errors occur, it is easy to damage important structures. For example, when minimally invasive surgery was conducted for pubic symphysis separation, if the Retzius space was not fully revealed and cannot be protected by gauze packing, it will be easy to damage the bladder and other important abdominal organs, thus requiring the surgeon to understand the structure of the pelvic abdominal organs [20]. The nail direction should be directed under X-ray fluoroscopy, thus increasing damage to both doctors and patients. The surgical procedure designed for this group is not only a change in the cut – it also reduces the possibility of a wound hernia without cutting off of the rectus sheath, tapered or abdominal rectus muscle, and white line, keep the intact structure of the groin middle window, and minimize damage to the blood vessels and nerves.

Therefore, the surgical approach not only reduces surgical trauma and shortens operative time, but also reduce the damage to blood vessels and nerves. The surgery led to pelvis fracture reduction and rigid fixation, to maintain good stability of pelvic, and the patient does not need bone traction after surgery. The patient will have a good functional recovery, and the contradictions between the patients undergoing pelvic fractures surgical treatment and associated injuries are more likely to be resolved.





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Simple retrospective comparison shows that minimally invasive surgery for pelvic fracture obtained satisfactory results. This approach is feasible and simple, with less trauma and fewer complications, and faster postoperative recovery. However, this study had a small sample size and the follow-up time was short, so a larger sample of patients is still needed in further investigations.

### Evaluation of minimally invasive fracture treatment technology

In evaluating minimally invasive surgical techniques to measure whether it is indeed a minimally invasive surgical procedure, the main focus should be on whether the time required for patients to return to normal life and work is significantly shortened compared with traditional surgery, whether the economic costs is lower, and whether the quality of medical care is improved. From the perspective of the development prospects of bone surgery, the minimally invasive method is the trend of fracture treatment.

## Conclusions

Traditional surgery refers to the surgery method used for many years after long practice and with wide practical application. The basic technical requirements for conventional surgery are sufficient for tissue to be revealed, which can increase patient body injury, postoperative complications, and slow healing. Minimally invasive surgery for the pelvic fracture has provided new opportunities in surgery, but the application of minimally invasive techniques, as with traditional surgical anatomy, must be based on good clinical skills. The efficacy of treatment of disease must be the priority.

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