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Application of minimally invasive percutaneous pedicle screw system in pelvic fractures

Feng Ma, Xiaohai Luo, Jingzu Ma, Ziyang Yang, Zhanchuan Yao, Tao Ma

Abstract

Our study intends to investigate the effect of minimally invasive percutaneous pedicle screw fixation on the treatment of pelvic fractures. Sixty patients with unstable pelvic fractures diagnosed in our hospital from January 2017 to December 2018 were selected. Patients were randomly assigned into external fixation group (EF) (20 cases), open reduction and internal fixation group (ORIF) (20 cases), minimally invasive percutaneous pedicle screw system fixation group (MIPPSSF) (20 cases) followed by analysis of the operation time, intraoperative blood loss, length of incision, postoperative complications, fracture reduction and Majeed score. Compared with ORIF group, MIPPSSF group displayed significantly shortened operation time and reduced length of incision and intraoperative blood loss (P<0.05), which was worse than EF group. In MIPPSSF group, the incidence of nail infection, radial nerve injury, deep vein thrombosis, and incision infection was 5% at 2 months after operation, 40% in the EF group and 25% in ORIF group (P<0.05). The fracture reduction of the three groups was improved. The rate of Majeed scores in MIPPSSF group, EF group and ORIF group were 75%, 75% and 90%, respectively without significant differences (P>0.05). Compared with EF, MIPPSSF for pelvic fracture can reduce the incidence of postoperative complications. Compared with ORIF, MIPPSSF can reduce surgical trauma and has a high clinical value. In conclusion, MIPPSSF can reduce the postoperative complications and surgical trauma after treatment of pelvic fracture, indicating that it might be used for an approach for treating pelvic fracture.

Keywords: Minimally invasive; percutaneous pedicle screw system fixation; pelvic fracture.

Introduction

Pelvic fractures are complicated fracture types that are rare in clinical practice and the incidence rate is low but has been increased in recent years. Traffic accidents are the most common causes of pelvic fractures, mainly in urban areas, with a pelvic fracture mortality rate of 3% and associated with high-energy trauma [1]. Pelvic fractures are often associated with severe combined injury and hemorrhagic shock. Surgical treatment of unstable pelvic fractures has been recognized, but the choice of surgical approaches for treating pelvic fractures is inconclusive, indicating that different surgical methods for the treatment of pelvic fractures might have some limitations [2]. The pedicle screw fixation system is also effective in the treatment of pelvic posterior ring fractures because of its effective fixation and minimal invasion. Minimally invasive percutaneous pedicle screw fixation is a relatively new surgical procedure for the treatment of anterior pelvic ring. Therefore, this study selected 60 patients with pelvic fractures, and treated them with 3 different surgical methods followed by comparison of the efficacy of these three surgical procedures in order to provide a better choice for the treatment of pelvic fractures in the future.

Department of orthopaedics, people's hospital of Ningxia Hui Autonomous Region, Yinchuan, Ningxia, China.
Running title: MIPPSS in pelvic fractures
Address correspondence to: Dr. Feng Ma, Department of orthopaedics, people's hospital of Ningxia Hui Autonomous Region, No. 301, Zhengyuan North Street, Jinfeng District, Yinchuan City, 750000, Ningxia, China. Tel: +86-0951-5920120; Fax: +86-0951-5920120; E-mail: gufang40590@126.com.

Materials and methods

Patients

There were 60 patients with surgical indications for pelvic fractures, including 36 males and 24 females with a median age of 40.8±11.0 years old (ranges: 15-68). Fracture classification: 22 cases of type B and 38 cases of type C. Causes of injuries: 38 cases of car accident injury, 15 fall injury, 7 crush injury. All patients were randomly and equally divided into open reduction and internal fixation (ORIF) group, minimally invasive percutaneous

pedicle screw system group (MIPPSSF) and external fixation (EF) group. The general data of these three groups of patients showed no significant differences (P>0.05) and were comparable.

Inclusion and exclusion criteria

Inclusion criteria: (1) Imaging (X-ray, CT) examination for unstable pelvic fractures; (2) with corresponding surgical indications, patients with informed consent, and signed informed consent; (3) Stable preoperative hemodynamics; (4) those who had been injured for ≥ 3 weeks of surgery; (5) those who had undergone surgery by the same group of physicians.

Exclusion criteria: (1) patients with mental illness; (2) pregnant and lactating women; (3) patients with malignant tumors; (4) severely ill patients.

MIPPSSF group

Most patients underwent spinal anesthesia. After that, they were placed in the supine position, routinely disinfected, and toweled. Made a 0.5~1 cm incision in the anterior iliac spine, separated the incision layer by layer, and probed the anterior and posterior spinous bone markers. Drilled the cortical bone below the highest point. It was 20 degrees to the sagittal plane of the human body and 20 degrees to the tail side. Screwed the pedicle screw with a diameter of 65 mm and a length of 60 cm. The second pedicle screw was placed in the same way. The assistant assisted in the use of indirect reduction technique to correct the rotational displacement of the anterior and posterior pelvis, and opened the subcutaneous tunnel. The pre-bent nail rod was inserted into the pedicle screw system through the subcutaneous tunnel. The C-arm X-ray aligning alignment was good without internal and external valgus and rotational displacement as well as no obvious separation of the pubic symphysis, and the fracture alignment was locked.

ORIF group

Take the median longitudinal incision of the abdomen (under the umbilicus to the upper edge of the pubic symphysis), cut the skin layer by layer, subcutaneously, cut the abdominal white line, and separate the rectus abdominals to the two. Side retraction, finger separation in the extraperitoneal space, protect important organs, the lower abdominal wall muscle, iliopsoas muscle, femoral nerve, external iliac vessels were pulled to the outside, and the pelvic organs such as cysts were protected with a sand pad and pulled backwards Upper, through the subperiosteal dissection, revealing the true pelvic margin (pubic symphysis to the ankle joint), revealing the fracture end, the front can be revealed to the pubic symphysis, and the posterior can be exposed to the inner side of the large hole of the ischial bone. Attention should be paid to the death crown (closed-hole blood vessels and the traffic branch of the extra-orbital or inferior epigastric vessels), and they were ligated. After fracture reduction under satisfactory vision, the reconstruction plate was utilized for screw fixation.

EF group

The anterior superior iliac spine was positioned and the incision was made at the posterior iliac crest. The 1.5 cm Kirschner wire was inserted under the periosteum of the medial and lateral ostium, and the two Kirschner wires were used to mark the cortex. Open the external fixation screw with reference to the direction of the Kirschner wire. Use the pedicle screw to screw the second external fixation screw into the anterior iliac spine. Place the external fixation screw on the opposite side. The surgeon used the external fixation screw as the external fixation screw. The handle corrected the multi-directional rotational displacement of the pelvis, and the external fixator link and the side block were installed. The C-arm X-ray fluoroscopy was acceptable without internal and external valgus and rotational displacement. The pubic symphysis was not separated, and the external fixator screw was locked.

Observation index

(1) Perioperative index: operation time, incision length, intraoperative bleeding, etc.
(2) Record the complications of the three groups 2 months after surgery, such as deep vein thrombosis, wound infection, radial nerve injury and so on.
(3) Matta standard [4] was applied to evaluate the fracture reduction effect of the patient: the fracture displacement <4mm is excellent, the fracture displacement is 4-10mm, the fracture displacement is 11-20mm, and the fracture displacement is >20mm.
(4) Majeed score [5]: Good rate: The Majeed score was used to determine the excellent and good rate of postoperative patients. The total score was 100 points, excellent: ≥85 points, good: 70-84 points, but: 60~ 69 points, difference: <60 points.

Statistical analysis

SPSS 22.00 software analyzed the measurement data. Non-parametric test was used for comparison

between groups. The count data were shown as percentage (%) and assessed by chi-square test. P <0.05 indicates a significance.

Results

Perioperative index comparison

All patients underwent successful operation. The operation time, intraoperative blood loss and length of incision in MIPPSSF group were significantly lower than those in ORIF group (P<0.05), but the operation time and intraoperative time, the amount of bleeding and the length of the incision were significantly higher than those in EF group (P<0.05) (Table 1).

Postoperative complications comparison

After observation, the incidence of nail infection, radial nerve injury, deep vein thrombosis and wound infection was 5% in MIPPSSF group, 40% in EF group and 25% in ORIF with a statistical difference among them (P=0.039) (Table 2). However, the MIPPSSF group had few postoperative complications compared to EF group (Table 3).

Majeed score excellent rate comparison

The excellent rate of Majeed scores in MIPPSSF group, ORIF and EF fixation group was 75%, 90% and 75%, respectively without statistical significances (Table 4).

Discussion

A pelvic fracture is a complicated fracture. This type of fracture often has a combined injury and hemorrhagic shock and requires to be treated in time. At present, the surgical methods for treating pelvic fractures include external fixation and open reduction and internal fixation. Although most patients have promising therapeutic effects, there are still several problems required to be solved. External fixation can increase pelvic stability, control pelvic volume to reduce bleeding, and reduce pelvic fracture with hemorrhagic shock during first aid mortality [6]. The external fixator can be used as a temporary fixation device to stabilize the pelvis and further treatment after the patient's condition is stable. The disadvantage of external fixator is the infection of nail, fixation strength is limited, and it has an influence on the sitting posture. There are several internal fixation options for open reduction, such as pelvic reconstruction plate, hollow compression screw, and tibial rod. The fixation strength is high, but it is necessary to do deep exposure in the pelvis with the risk of damage to important organs and the relative trauma. Moreover, it has been reported that the incidence of nerve injury during treatment of pelvic fractures was 1.9% [7]. According to clinical practice, the pedicle screw system is mainly used as an internal fixation method for the spine, which has the advantages of shape and high fixation strength. Some scholars have proposed the application of subcutaneous internal fixators for the treatment of anterior pelvic ring fractures [8]. The pedicle screw system is a relatively new minimally invasive technique. Its biomechanical principle is similar to that of the external fixator. The difference between the two is that the pedicle screw system is placed under the skin without exposure of nail path, thus reducing the infection rate. The pedicle screw system usually does not expose the fracture end, and both sides of the anterior inferior tibiofibular incision are closed by indirect technique, fixed by subcutaneous tunnel, and the tunnel is established under the skin to avoid the important structure. A periosteal stripper can be completed. It is not necessary to make the steel plate fit to the pelvis in the case of open reduction and internal fixation, which is in line with the biological fixation of the BO concept. However, the indirect reduction technique of the surgeon is relatively high, and the complicated fracture with large displacement requires detailed preoperative planning, and can be applied in emergency. The minimally invasive percutaneous pedicle screw system has small trauma, less bleeding with simple operation, and can be used as a new surgical procedure for minimally invasive treatment of pelvic fractures.

This study compared the clinical outcomes of minimally invasive percutaneous pedicle screw fixation, external fixation, and open reduction and internal fixation for unstable pelvic fractures. Our results showed that minimally invasive percutaneous pedicle screw system had shorter operation time, intraoperative blood loss and length of incision in the fixed group compared with open reduction and internal fixation group (P<0.05). The main reason is that pedicle screw fixation only needs to be closed and reset, without exposing the fracture end, without causing damage to the soft tissue and blood vessels of the pelvis. Among the postoperative complications, the minimally invasive percutaneous pedicle screw system was 5%, the external fixation was 40%, and the open reduction and internal fixation was 25% with a significant difference (P< 0.05), indicating that minimally invasive percutaneous pedicle screw fixation can reduce postoperative complications compared with external fixation. Because the external fixation frame has a nail path, it has a certain impact on the daily life of patients, and the daily care

requirements are needed. Among the three groups, the excellent rate of Majeed score was 75% in the minimally invasive percutaneous pedicle screw system, 75% in the external fixation group, and 90% in the open reduction and internal fixation group. Although the rate of Majeed in the open reduction and internal fixation group was higher, it did not reach a statistical significance when compared with other groups since the Majeed score was affected by subjective factors.

Our study has some limitations. The sample size of each group was relatively small, and some patients had a short follow-up time, which might not truly reflect the real situations. In the future, more patient enrollment with longer follow-up is required to verify the findings.

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Disclosure of conflict of interest

None.

Conclusion

Compared with open reduction and internal fixation, minimally invasive percutaneous pedicle screw system for the treatment of pelvic fractures can reduce surgical trauma and postoperative complications, indicating that it might be used as a novel approach for the treatment of pelvic fracture in the future.

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Table legends

Table 1. **Comparison of operation time, intraoperative blood loss and length of incision.**

Group	N	Operation time (Time)	Intraoperative blood loss (ml)	Incision length (cm)
MIPPSSF group	20	26.00	41.50	3.60
EF group	20	17.00	22.00	5.40
ORIF group	20	127.00	159.50	8.55
H value	-	49.862	51.205	50.947
P value	-	0.000	0.000	0.000

Table 2. **Comparison of postoperative complications.**

Group	Nail infection	Radial Nerve injury	Deep vein thrombosis	Wound infection	Total (%)
MIPPSSF group	0	0	0	1	1 (5%)
EF group	2	1	2	3	8 (40%)
ORIF group	0	2	1	2	5 (25%)
x^2 value	-	-	-	-	7.065
P value	-	-	-	-	0.039

Table 3. **Comparison of postoperative complications in 3 groups.**

		Group			Total (%)
		MIPPSSF (N)	EF (n)	ORIF (n)	
Complications	Yes	1	8	5	14 (23%)
	No	19	12	15	46 (77%)
Total (n)		20	20	20	60

Table 4. **Majeed score comparison rate comparison.**

Group	Excellent	Well	Good	Poor	Excellent rate (%)
MIPPSSF group	12	3	5	0	75%
EF group	12	3	4	1	75%
ORIF group	12	6	2	0	90%
x^2 value	-	-	-	-	4.507
P value	-	-	-	-	0.652