

## Case Report

# Clinical and Radiological Outcomes after External Fixator as a Definitive Fixation in Patients with Unstable Pelvic Ring Fracture

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## Abstract

### Introduction

External fixators are commonly applied to pelvic ring fractures mainly for temporary stabilization. However, there are no reports that provide patient reported outcome measures. We report clinical and radiological outcomes following external fixation (EF) performed as a definitive fixation method in patients with unstable pelvic ring fractures, including complications and physical/mental health status assessment using the Short-Form 36-item Health Survey (SF-36).

### Methods

Data of patients with unstable pelvic ring fractures were retrospectively analyzed using an electronic medical database. Inclusion criteria were patients with unstable pelvic ring fracture who underwent EF as a definitive fixation method and followed up for a minimum of 12 months.

### Results

This study included 25 patients. The grade of pelvic ring fracture was type B in 8 cases (32%) and type C in 17 cases (68%). The mean Majeed score was  $84.0 \pm 19.3$ . Moreover, 15 patients were rated "excellent," 7 "good," 1 "fair," and 2 "poor." The outcome of physical function according to the SF-36 was significantly worse than that of the average Japanese population.

### Conclusion

Favorable functional outcomes were reported by 88% of patients after EF as a definitive fixation method for unstable pelvic ring fracture. EF is a potential treatment option for unstable pelvic ring fractures in physically fragile patients or patients with other complications.

(Key words: Pelvic ring fracture, External Fixation, SF-36, sexual function)

## Introduction

Pelvic injury occurs in approximately 3% of all fractures and is mainly caused by high-energy trauma such as motor vehicle accidents or falls. Pelvic bones are surrounded by musculoskeletal and neurovascular structures; therefore, pelvic ring fractures induce massive bleeding. External fixators are commonly applied to pelvic ring fractures mainly for temporary stabilization. External fixation (EF) may decrease the amount of bleeding to help patients

recover from hemodynamically unstable conditions. EF is often followed by internal fixation (IF) because of the risk of continuous application of external fixators such as pin-site infection, loss of reduction, and chronic osteomyelitis. Conversely, several recent studies have described the efficacy of longer period EF as a definitive fixation method<sup>1-3</sup>. However, our literature search found no reports that presented patient reported outcome measures (PROM) such as the Short-Form 36-item Health Survey (SF-36).

We report the clinical and radiological outcomes after EF as a definitive fixation method in patients with unstable pelvic ring fracture including complications and physical/mental health status assessment using SF-36.

**Methods**

**Patient selection**

This case series was conducted in the Department of Orthopedic Surgery of our institution. The institutional review board of the ethics committee at our institution approved the study and waived the requirement for formal written informed consent due to the retrospective nature of the study.

The data of patients with unstable pelvic ring fractures between 2004 and 2009 were extracted from an electronic medical database and analyzed. During the study period, our hospital trauma team did not routinely perform IF for unstable pelvic ring fractures. Currently, IF for unstable pelvic ring fractures is performed after initial treatment. However, EF for unstable pelvic ring fractures is occasionally performed as a temporary fixation method, and as a definite fixation in patients with complications such as open fracture, neurovascular, and/or head injury. Inclusion criteria were patients with unstable pelvic ring fracture undergoing EF as a definitive fixation method and followed up for a minimum of 12 months. Exclusion criteria were patients who were lost

to follow-up, died of causes not related to musculoskeletal injuries, or underwent open reduction and internal fixation.

Patient enrollment is shown in Figure 1. Initially, 50 patients with unstable pelvic ring fractures were identified. Ten patients with other treatments, such as one stage plate or screw fixation, were excluded. In addition, 5 patients who were too hemodynamically unstable to undergo the intervention and died after admission, 4 patients with staged conversion to IF, and 6 patients who were lost to follow-up were excluded. Thus, we included 25 patients with unstable pelvic ring fracture treated using EF as a definitive fixation method, and they were followed up for a minimum of 12 months. Pelvic ring fracture was graded according to the AO-Müller/Orthopaedic Trauma Association (AO/OTA) classification.

**Surgical procedure (EF)**

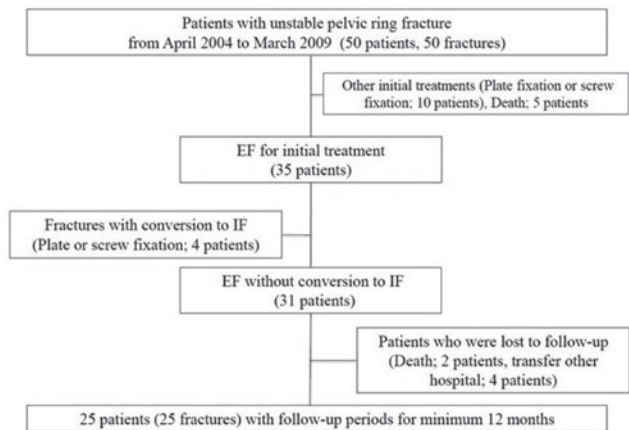
Initially, we performed arterial embolization as early as possible to control extravasation shown on vascular computed tomography. After confirming that the extravasation, we performed EF as early as possible in the emergency room or surgical theater to patients with unstable pelvic ring fracture. No formal treatment protocol for unstable pelvic fractures was used during the study period. Therefore, the initial treatment was based on the attending surgeon's preference.

We performed high route EF in which two or three unilateral 5-mm half pins were inserted into each iliac crest to provide bridging fixation (Fig. 2).

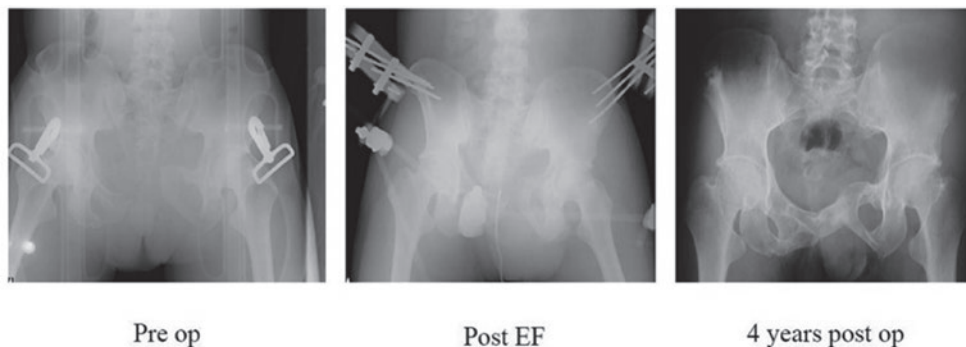
A patient with unstable pelvic ring fracture was treated with EF. The patient was a 33-year-old man who had a motor bicycle accident. The type of fracture was AO 61-C2, and the injury severity score (ISS) was 41. He had complications such as bladder rupture, urethral damage, subdural hematoma, and other conditions, so we chose to perform EF. Three unilateral 5-mm half pins were inserted into each ilium (Fig. 2). Translation did not achieve perfect reduction, but the bone healed and the Majeed score was 68.

**Therapeutic protocol after surgery**

The time elapsed before partial weight bearing (WB)



**Fig. 1** Flowchart of patient enrollment.



**Fig. 2** A patient with pelvic ring fracture undergoing EF

was permitted varied according to injury patterns and concomitant injuries. WB by the lower limb was prohibited for an average of  $6 \pm 4$  weeks (range, 2–12 weeks) after surgery.

**Clinical evaluations**

Demographic data, mechanism of injury, AO/OTA classification, residual displacement (defined as Yes if  $\geq 10$  mm and No if  $< 10$  mm), ISS, Majeed score, SF-36, visual analog scale, questionnaire about sexual dysfunction, satisfaction, and residual disability were evaluated.

**Results**

In total, 25 patients (male/female, 14/ 11) were included in this study. The mean age was  $45.0 \pm 19.0$  years (range: 18–79 years). The follow-up period was  $30 \pm 15$  months (range: 12–48 months). The pelvic ring fractures were type B1 in 3 cases (12%), type B2 in 4 cases (16%), type B3 in 1 case (4%), type C1 in 12 cases (48%), and type C2 fracture in 5 cases (20%) (Table 1). The mechanisms of injury included six motorbike accidents, six car accidents, five falls, five machine collapses, two bicycle accidents, and one snowboarding accident. There were residual displacement in 2 of 8 type B (25%) and 7 of 17 type C (41%) fracture patients. The average ISS was  $21.7 \pm 9.1$  (range: 9–41). The mean duration of EF application was  $6.6 \pm 2.1$  (range: 2–11) weeks. The mean Majeed score was  $84.0 \pm 19.3$  (range: 40–100). There were 15 “Excellent” patients, 7 “Good” patients, 1 “Fair” patient, and 2 “Poor” patients. Two patients with poor scores sustained neurological injuries. Physical function according to SF-36 was significantly worse compared to that of the average Japanese individual. All patients were followed up for a minimum of 12 months. The timing of scoring was 12–48 months after treatment (Fig.3). We obtained responses to the questionnaire on sex life and satisfaction with treatment from 16/25 patients (60%). Twelve patients had a normal sex life without any pain. Two patients had a normal sex life with slight pain, one patient barely had a sex life with slight pain, and one patient could not have a sex life due to severe pain; these four patients had a disability pertaining to their sex life.

**Table 1. Orthopedic Trauma Association (OTA) classification list**

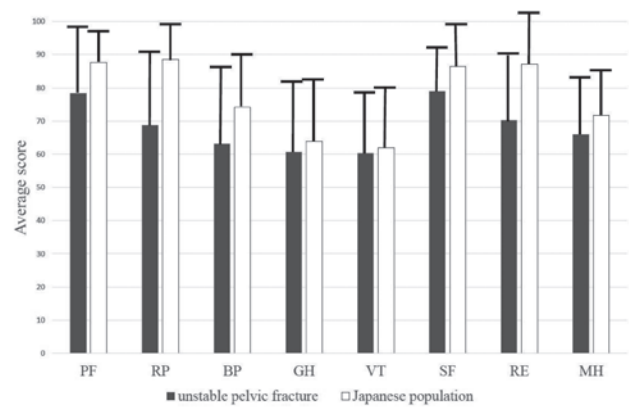
Bone, segment	Total		
Type, Group			
61B-1	0	C-1	12
B-2	7	C-2	5
B-3	1	C-3	0
Total	8	17	25

These patients were all men and included 2 cases of type B and 2 cases of type C fractures (Fig.4). Fifteen patients were satisfied with the treatment; 9 patients responded that they would definitely select the same treatment, and the remaining 6 patients responded that they would probably select the same treatment.

**Discussion**

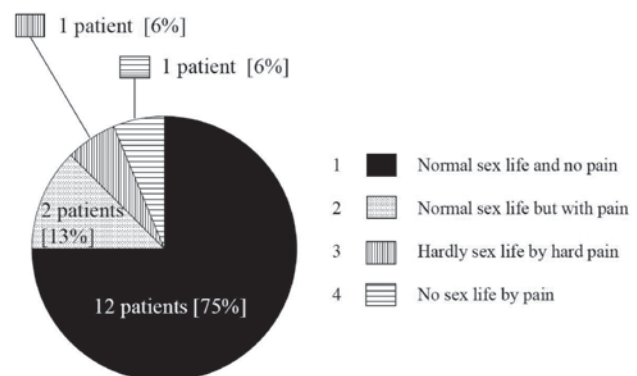
Our study showed the clinical and radiological outcomes of patients with unstable pelvic ring fractures who underwent EF as a definitive fixation method. Currently, no studies have evaluated the quality of life of these patients undergoing EF as a definitive fixation method using PROM. The most important finding in this study was that 88% of the patients reported favorable functional outcomes.

The Majeed score was favorable in most of the patients in this study. Henderson et al. reported that displacement  $> 10$  mm was associated with increased persistent pain and work disability<sup>4</sup>. Lindahl et al. reported an association



**Fig. 3 The average of the SF-36 subscales (study participants and population norm)**

SF-36; short-form 36-item health survey PF; physical functioning RP; role physical BP; bodily pain GH; general health VT; vitality SF; social functioning RE; role emotional MH; mental health



**Fig. 4 Responses to answers on sex life**

between excellent radiographic results and better functional outcomes<sup>5</sup>. These reports suggested a correlation between residual displacement and functional outcomes. Pohlemann et al. reported that good functional outcomes were obtained in 27% of patients with type C pelvic ring fractures with < 5 mm translation treated using IF with a plate and screw<sup>6</sup>. The study showed that anatomic reconstruction of the pelvic ring is an important factor for good or excellent clinical results, although other parameters (SI dislocations, primary neurological/urological injuries) can lead to unsatisfactory results after pelvic ring reconstruction.

In our study, there were 9 cases with residual posterior displacement of > 10 mm including 5 type C2 patients and 4 neurologically deficient patients. The Majeed score was not favorable in three patients. These patients (1 "Fair" and 2 "Poor") had type C fractures and retained neurological deficit. Two of the three patients (1 "Fair" and 1 "Poor") sustained residual posterior displacement of > 10 mm. Our results showed that type C fractures, neurological deficit, and residual posterior displacement of > 10 mm have a negative correlation with PROM.

There have been several studies on long-term functional outcomes after unstable pelvic ring fractures. Suzuki reported similar clinical outcomes and complication rates (Table 2)<sup>7</sup>. We report the clinical and radiological outcomes after EF as a definitive fixation method. Suzuki reported functional outcomes of 23 patients who were treated conservatively, 22 with EF and 12 with IF. Fair functional outcomes could be obtained with EF as a definitive fixation method for patients having unstable pelvic ring fractures with other complications or fragile physical conditions. However, IF should be performed after EF in patients with type C fractures and a residual posterior displacement > 10 mm to obtain better functional outcomes.

Our results and those of Suzuki showed that unstable pelvic ring fractures caused sexual functional deficiency. In our study, the rate of sexual functional deficiency after treatment of unstable pelvic ring fracture was 25%. Similarly, several authors have reported rates of sexual functional deficiency between 5% and 44%<sup>8-10</sup>. In our study, sexual functional deficiency after treatment of unstable pelvic ring fracture was significantly related with SF-36 scores,

**Table 2. Comparison of our study with the study by Suzuki et al. SF-36: Short-Form 36-item Health Survey**

	Suzuki et al.	Our study
Majeed Score	79.7	84
SF-36	66.4	67.7
Sexual function impairment	26%	25%
Neurology impairment	28%	16%

particularly physical functioning and body pain. Patients may have given artificially higher or lower scores when completing self-report forms related to personal matters such as sex. This can lead to different results in the statistical analysis.

This study had several limitations. Firstly, this was a retrospective study. A certain amount of bias might exist. Secondly, we did not have a clearly standardized postoperative protocol to permit sitting, weight-bearing walk, and free gait. The timing of these activities and removal of the external fixator varied among the patients. Thirdly, the number of patients and recovery rate for questionnaires was insufficient to obtain enough statistical power. There was a certain risk of false negative results. Fourthly, we did not use the stress examination with fluoroscopy under anesthesia to check stability of the pelvic ring and the need for operative stabilization. Despite these limitations, this was the first study to report functional outcomes after EF as a definitive fixation method for unstable pelvic ring fractures. Currently, no studies have evaluated patients with unstable pelvic ring fracture undergoing EF as a definitive fixation method. Therefore, we believe this is a strength of our study.

#### Conflict of interest

All authors have and declare that: (i) no support, financial or otherwise, has been received from any organization that may have an interest in the submitted work; and (ii) there are no other relationships or activities that could appear to have influenced the submitted work.

#### Conclusion

Favorable functional outcomes were reported in 88% of patients after EF as a definitive fixation method for unstable pelvic ring fracture. EF for unstable pelvic ring fractures is a treatment option to be considered in patients with other complications or fragile physical conditions.

#### References

1. Galois L, Pfeffer F, Mainard D, Delagoutte JP. The value of external fixation for unstable pelvic ring injuries. *Acta Orthop Belg.* 2003; 69(4): 321-7.
2. Guthrie HC, Owens RW, Bircher MD. Fractures of the pelvis. *J Bone Joint Surg Br.* 2010; 92(11): 1481-8.
3. Cole PA, Gauger EM, Anavian J, Ly TV, Morgan RA, Heddings AA. Anterior pelvic external fixator versus subcutaneous internal fixator in the treatment of anterior ring pelvic fractures. *J Orthop Trauma.* 2012; 26(5): 269-77.
4. Henderson RC. The long-term results of nonoperatively treated major pelvic disruptions. *J Orthop Trauma.* 1989; 3(1): 41-7.
5. Lindahl J, Hirvensalo E. Outcome of operatively treated

- type-C injuries of the pelvic ring. *Acta Orthop.* 2005; 76(5): 667-78.
6. Pohlemann T, Gansslen A, Schellwald O, Culemann U, Tscherne H. Outcome after pelvic ring injuries. *Injury.* 1996; 27; Suppl 2: B31-8.
  7. Suzuki T, Shindo M, Soma K, Minehara H, Nakamura K, Uchino M, et al. Long-term functional outcome after unstable pelvic ring fracture. *J Trauma.* 2007; 63(4): 884-8.
  8. Machtens S, Gansslen A, Pohlemann T, Stief CG. Erectile dysfunction in relation to traumatic pelvic injuries or pelvic fractures. *BJU Int.* 2001; 87(5): 441-8.
  9. Harwood PJ, Grotz M, Eardley I, Giannoudis PV. Erectile dysfunction after fracture of the pelvis. *J Bone Joint Surg Br.* 2005; 87(3): 281-90.
  10. Metze M, Tiemann AH, Josten C. Male sexual dysfunction after pelvic fracture. *J Trauma.* 2007; 63(2): 394-401.

# 創外固定で治療した不安定型骨盤輪骨折の治療成績

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## 要 約

### 背景

創外固定は不安定型骨盤輪骨折に対する初期治療として一般的だが、治療成績に対する報告はほとんどない。私たちは不安定型骨盤輪骨折に対して創外固定のみで治療した場合の治療成績を調査したため報告することとした。

### 方法

不安定型骨盤輪骨折患者を後ろ向きに調査した。対象は不安定型骨盤輪骨折に対して創外固定のみで治療した中で、12カ月以上経過観察できた患者とした。

### 結果

今回の研究対象は25例であった。骨盤骨折のAO分類の内訳は、Type Bが8例（32%）、Type Cが17例（68%）であった。Majeed scoreは平均84.0+/-19.3. excellent 15例, good 7例, poor 2例であった。SF-36の身体機能評価は日本人平均より低いスコアとなった。

### 結論

創外固定のみで治療した不安定型骨盤輪骨折の患者の88%は良好な治療成績を示していた。合併症や全身状態不良により内固定ができない不安定型骨盤輪骨折患者に対して、創外固定のみで治療を行うことは一つの選択肢として検討の余地がある。

（キーワード：骨盤輪骨折，創外固定，SF-36，性機能障害）