

Innovations in Sacral Fracture Management: A Comparative Study of Open vs Closed Reduction Outcomes

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ABSTRACT

Background: Sacral fractures represent a significant challenge in orthopedic trauma care, particularly given their occurrence in both high-energy traumas in young individuals and low-energy falls in the elderly. The choice between conservative treatment and surgical intervention, including open reduction and internal fixation (ORIF) versus closed reduction and percutaneous fixation (CRIF), remains contentious due to varying outcomes reported in the literature.

Objective: This study aimed to compare the clinical outcomes, radiologic healing, functional recovery, and complications associated with ORIF and CRIF techniques in the treatment of sacral fractures.

Methods: A prospective study that was conducted on 20 patients with sacral fractures who were divided into two groups: 10 patients underwent CRIF, and the other 10 underwent ORIF. Clinical evaluation, radiological assessments, and functional outcomes were meticulously recorded.

Results: The AO classification showed a statistical significance in fracture types between the groups ($p=0.015$). However, operative time and time to operation were not significantly different ($p=0.130$ and $p=0.587$ respectively). Functional outcomes, including sitting, standing ability, and sexual function, which showed no significant differences ($p>0.05$). The incidence of complications was low, with no significant differences in outcomes between the two treatment modalities.

Conclusion: Both ORIF and CRIF were viable options for the treatment of sacral fractures, with no significant differences in clinical outcomes, functional recovery, or complication rates.

Keywords: Sacral fractures, Open reduction and internal fixation, Closed reduction and percutaneous fixation, Clinical outcomes, Functional recovery.

INTRODUCTION

Sacral fractures encompass a diverse range of injuries that typically occur in younger individuals due to vehicular accidents and high falls, or in older, osteoporotic patients as a result of minor incidents [1].

Statistics show that sacral fractures are not associated with osteoporosis occur at a rate of 2.1 per 100,000 individuals. Meanwhile, fractures related to osteoporosis are observed in 1–5% of the elderly population at risk. Such fractures are common in young adults following incidents involving significant force, or in older adults and those with osteoporosis after falls from less significant heights [2].

A majority of research advocates for non-surgical treatment of sacral fractures, given the ambiguity surrounding the surgical intervention for these injuries. Nonetheless, there are studies suggesting that surgical fixation may be necessary for patients with multiple traumas to avoid systemic complications and issues related to prolonged bed rest [3].

Methods for stabilizing such fractures, including open lumbopelvic fixation with traditional iliac screws (LPF), local plate osteosynthesis, trans-iliac bars, and iliosacral screw fixation (ISF), have been examined extensively [4].

The debate continues whether injuries to the posterior pelvic ring are more effectively managed through open reduction and internal fixation (ORIF) or

closed reduction with percutaneous iliosacral screw (CRIF) [5].

Papakostidis and colleagues [6], after reviewing English literature from the past three decades, determined that there is a lack of definitive evidence to guide clinical decisions for the best treatment approach for unstable pelvic ring injuries.

This study aimed to evaluate and compare the outcomes between open and closed reduction techniques in the treatment of sacral fractures.

PATIENTS AND METHODS

This prospective study involved 20 individuals with sacral fractures that was conducted at Helwan University Hospital and El-Helmia Military Hospital over a one-year timeframe.

Inclusion criteria: Patients without osteoporotic sacral stress fractures, unstable anterior pelvic ring disruptions and sacral dysmorphism, or pathological metastatic sacral fractures.

Exclusion criteria: Individuals who declined participation, those with osteoporotic sacral stress fractures, patients with sacral fractures and unstable anterior pelvic ring disruptions, those with sacral dysmorphism from the group receiving percutaneous

iliosacral treatment, and patients with sacral fractures due to metastatic disease.

Participants were allocated into two distinct groups for treatment. Group A consisted of 10 patients who underwent closed reduction and percutaneous iliosacral or trans-iliac bridging system (CRIF). Group B that comprised 10 patients, who received open reduction and internal fixation with plated pedicle screws, along with connecting bars in cases involving spinopelvic dissociation (ORIF).

All patients suspected of having sacral fractures were subject to thorough medical history reviews and physical examinations. In addition to extensive radiological evaluations, which included radiographic pelvis examinations from various angles, CT scans with 3D reconstructions to precisely identify the fracture and ensure safe screw placement for those in the percutaneous group, and MRI of the lumbosacral spine. A comprehensive neurological examination was also conducted and recorded for each patient.

Ethical considerations:

The study was done after being accepted by The Research Ethics Committee, Helwan University Hospital and El-Helmia Military Hospital. All patients provided written informed consents prior to the enrolment. The consent form explicitly outlined their agreement to participate in the study and for the publication of data, ensuring protection of their confidentiality and privacy. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

For the statistical analysis, data was processed using SPSS (Statistical Package for the Social Sciences) version 26. The study described quantitative data through means and standard deviations, while categorical data were presented through their frequencies. The Chi-square test and Fisher exact test were used for comparing categorical variables, whereas the independent sample t-test and Mann-Whitney test were applied for quantitative data comparisons, depending on the data distribution. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

There was statistically non-significant difference between the studied groups regarding gender, age, AO (Arbeitsgemeinschaft für osteosynthesfragen)

classification, operative time and time till operation (Table 1).

Table (1): Comparison between the studied groups regarding demographic data

Parameter	Closed reduction group	Open reduction group	p
	N=10(%)	N=10(%)	
Gender:			
Female	4 (40%)	3(30%)	0.652
Male	6 (60%)	7 (70%)	
Age	31.42 ± 10.24	31.5 ± 6.8	0.748
AO classification:			
61B2	6 (40%)	4 (40%)	0.015
61B3	1 (10%)	6 (60%)	
61C1	2 (20%)	0 (0%)	
61C2	1 (10%)	0 (0%)	
Operative time (min)	39.12 ± 8.5	41.10 ± 3.12	0.130
Time to operation (day)	5.5 (3 – 13)	12 (4 – 17)	0.587

χ²: Chi square test, t independent sample t test, t independent sample t test, Z: Mann Whitney test, IQR interquartile range

There was statistically non-significant difference between the studied groups regarding sitting, standing ability or sexual ability (Table 2).

Table (2): Comparison between the studied groups regarding outcome till end of study

Parameter	Closed reduction group	Open reduction group	p
	N=10(%)	N=10(%)	
Sitting:			
Good	10 (100%)	8 (80%)	0.136
Excellent	0 (0%)	2(20%)	
Standing ability:			
Fair	2 (20%)	2 (20%)	0.365
Good	6(60%)	4 (40%)	
Excellent	2 (20%)	4 (40%)	
Sexual ability:			
No	2 (20%)	0 (0%)	0.489
Fair	2 (20%)	2 (20%)	
Good	5(50%)	6(60%)	
Excellent	1 (10%)	2 (20%)	

Chi square for trend test

DISCUSSION

Vertically unstable pelvic fractures, making up about 6% of all fractures, often co-occur with sacral fractures and are linked to high mortality and morbidity rates, as noted by **Hak et al.**,^[7] Tile's classification^[8] describes a fully unstable pelvic ring injury as a complete break of the posterior sacroiliac complex along with an injury to the anterior pelvic ring, making the pelvis unstable in every direction.

To enhance treatment outcomes, there's a growing preference for a more aggressive treatment strategy, particularly the internal fixation of the posterior disruption using techniques such as iliosacral screws and transsacral bridging systems, popularized by **Rouff et al.**^[9]. These screws, which can be inserted percutaneously after achieving a satisfactory closed reduction, address both sacroiliac joint dislocations and sacral fractures.

However, while iliosacral screw fixation is a recognized method for treating posterior lesions, its effectiveness and the choice between ORIF versus CRIF for posterior pelvic ring injuries remain debated topics. ORIF is often preferred for managing vertically unstable fractures of the posterior pelvic ring, aiming to mitigate risks like exsanguination, sepsis, multiorgan failure, chronic pain, and functional impairments. Yet, the open posterior approach, commonly used for fixation, is associated with a higher risk of complications, including wound healing issues and infections, as indicated by **Gray et al.**^[10].

CRIF merges the benefits of ORIF with those of non-invasive treatments, offering a minimally invasive option for screw placement. It stands as a credible alternative to ORIF for these fractures, contingent upon achieving a satisfactory reduction, as suggested by **Liuzza et al.**^[11].

The aim of this study was to compare the clinical, radiological, and functional outcomes, as well as the complications associated with open and closed reductions in sacral fracture treatments.

There were no significant statistical differences in gender or age between the two groups. **Stover et al.**^[12] mentioned that the disparity in intraoperative times between groups is influenced by various factors such as surgeon skills, operating room and imaging facilities, the patient's general condition, and the trauma's severity.

Our research also assessed the intraoperative blood loss in post-pelvic ring injury treatments through CRIF or ORIF. The average blood loss for CRIF was 150-250 cc, with an average blood transfusion of one unit (500 cc), compared to 750-850 cc for ORIF at the study's outset, which improved to 600-700 cc with an average of two units (1000 cc) transfused in the last six cases.

In the closed reduction group, two patients experienced broken operative guide wires, a finding that is consistent with **Elzohairy and Salama**^[5], and **Ruatti et al.**^[13], who reported broken guide wires in their studies. **Farouk et al.**^[14] documented two cases of

radiculopathy in the CRIF group, with no neurological injuries in the ORIF group. Furthermore, they reported one infection after percutaneous iliosacral screw fixation in an immunocompromised patient and one deep infection in the ORIF group.

From the study's commencement, we enforced a strict anticoagulant regimen for both groups. One CRIF group patient developed DVT, while no DVT cases were found in the ORIF group. **Elzohairy and Salama**^[5] noted three DVT cases in the CRIF group and one in the ORIF group.

Outcome-wise, our study found no significant difference between the groups. **Ruatti et al.**^[13] stated that quality percutaneous reduction typically suffices for sacral nerve root decompression.

Despite various techniques for open and closed reductions, achieving anatomical pelvis restoration remains challenging^[12]. **Jacob et al.**^[15] concluded that CRPF with CT-guided sacroiliac screw fixation is effective, minimally invasive, and stable for treating longitudinal posterior pelvic ring fractures. **Farouk et al.**^[14] and **Lindsay et al.**^[16] also highlighted the effectiveness of CRIF in achieving accurate reduction and anatomical restoration in type 3 posterior pelvic ring injuries, comparing favorably with the standard ORIF approach.

CONCLUSIONS

Prompt stabilization of vertically unstable pelvic fractures significantly decreases morbidity and enhances long-term functional outcomes. Utilizing closed reduction and percutaneous iliosacral screws effectively addressed posterior lesions with minimal morbidity. Nonetheless, our findings indicated that achieving the best anatomical outcomes necessitates rigid internal fixation of the anterior lesion. Surgical decision-making varies based on the timing of surgery or referral, the nature of the fracture, the overall health of the patient, skin condition, concurrent ipsilateral acetabular fractures, and the practicality of closed reduction.

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