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ORIGINAL ARTICLE

The Role of Spinal Instability in Treating Unstable Infected Fractures

SHAHID HUSSSIN[1], MOHSIN ALI KHAN[2], TAUSEEF RAZA[3], MUHAMMAD MUNEER HAIDER[4], JUNAID JAVAID[5], AKKAD RAFIQ[6], YOUSAF SULAIMAN KHAN[7], MIAN IFTIKHAR UL HAQ[8]

[1]*Consultant Orthopaedic Surgeon, Department of Orthopaedics, Shahid Hussain Orthopaedic and General Hospital, Timergara*
[2]*Orthopedic Surgeon, Health Department, Sandeman Provincial Hospital, Quetta*
[3]*Assistant Professor, Department of Orthopedics, KMU Institute of Medical Sciences, Kohat*
[4]*Consultant Orthopaedic Surgeon, Dr Faisal Masood Teaching Hospital, Sargodha*
[5]*Assistant Professor Orthopedic Surgery, Maryam Memorial Hospital, Phase 4, Bahria Town, Rawalpindi*
[6]*Associate Professor Orthopaedic Surgery, Rahbar Medical and Dental College, Lahore*
[7]*Postgraduate Resident, Department of Orthopedic and Spine Surgery Unit, Hayatabad Medical Complex, Peshawar*
[8]*Assistant Professor, Neurosurgery Unit, Hayatabad Medical Complex Hospital, Peshawar*
Correspondence to: Mian Iftikhar ul Haq, Email: drmiulhaq@gmail.com

ABSTRACT

Background: Unstable infected fractures of the spine present a complex challenge in orthopedic and spinal surgery. The management of these fractures requires a comprehensive approach to control infection, achieve fracture healing, and maintain spinal stability.

Objective: To investigate the impact of spinal instability on infection resolution, fracture healing, and functional recovery in patients with unstable infected fractures.

Methods: This prospective cohort study was conducted at KMU Institute of Medical Sciences, Kohat during June 2022 to January 2023. The study involved 55 patients with unstable infected fractures. Patients aged >18 years, diagnosed with unstable fractures involving infection, and with evidence of spinal involvement based on clinical and radiological assessments were included in the study.

Results: 87.3% infection resolution rate, with 90.9% of patients achieving spinal stability postoperatively. The overall fracture healing rate was 90.9%, with a nonunion rate of 9.1%. Functional recovery, as measured by ODI scores, improved significantly, with a mean reduction in ODI scores from 38.5 preoperatively to 14.2 postoperatively. Patients who achieved spinal stability and infection resolution showed greater improvements in functional outcomes. However, 18.2% of patients experienced complications, including persistent infection, hardware failure, and nonunion.

Conclusion: It is concluded that spinal stability plays a critical role in the successful treatment of unstable infected fractures. Effective infection control, fracture healing, and maintaining spinal stability are essential for achieving optimal functional recovery.

Keywords: Patients, Management, Non-union, Orthopedic, Instability

INTRODUCTION

The management of unstable infected fractures presents a significant challenge in orthopedic surgery due to the complex interplay of infection, mechanical instability, and the need for effective fracture healing.

The principles for managing fractures in different body regions apply directly to spinal instability examinations because spinal fractures usually arise in discussions about spinal stability[1]. The combination of compromised skeletal structure and simultaneous infection and instability leads to an active impeding mechanism which increases nonunion rates and deforms the structure and causes disability over the long term[2]. Spinal instability treatment for fractures requires analysis of mechanical bone stability with additional investigation of infection prevention and tissue health and biomechanical stressors active during healing stages. The treatment of unstable infected fractures requires thorough attention to antibiotic treatment along with surgical clearance of infection and multiple stable implant procedures[3].

Always challenging for clinicians to handle is the category of unstable fractures when such cases present infection. These unstable fractures which cannot retain their normal structure get classified as unstable by doctors while the combination of infection makes them especially challenging[4]. Infection brings new complications to healing by allowing bacterial growth while creating abscesses and triggering systematic inflammatory reactions that affect both patient recovery and health condition. Moreover, the presence of infection necessitates the implementation of aggressive antibiotic therapy, frequent surgical interventions, and careful monitoring of the wound and systemic condition[5]. The degree of instability along with infection risk depends heavily on how much damaged tissue exists and which body part gets fractured and what caused the break. Poor nutritional condition together with diabetes and immunocompromised status make the treatment of these patients particularly complex. Medical providers need to analyze multiple factors before developing treatment plans for unstable infected fractures as reported in[6]. Spinal instability usually develops following breaks in the spinal structure but in fracture cases the definition of instability describes how the bones and supporting tissues perform regarding mechanical stress. The destruction of bones and damaged joint surfaces or soft tissues during infected fractures creates instability that appears through misalignment of bones or leads to non-union and might cause bone deformation[7]. Spinal instability from infected fractures leads to a reduction of load-bearing ability that causes severe impairment to patient functional capability and life quality. When managing fractures, surgeon intervention becomes necessary because spinal instability cannot heal properly without stability restoration[8]. The treatment uses fixation tools like plates or screws or rods structurally support the disordered area and includes procedures that cleanse infected tissues and help healthy tissue develop. Bone infections transform the healing process because they result in tissue death while simultaneously breaking down connective tissues and weakening nearby tissue strength. Proper mechanical alignment becomes hard to maintain because of these factors which are required for healing[9]. Multiple influences exist between infection and mechanical instability.. The body loses its ability to heal the fracture site because the instability increases when infection occurs. To achieve proper healing surgeons must eliminate dead bone tissue known as sequestra from the area since bone infection (osteomyelitis) causes these formations[10].

Objective: To investigate the impact of spinal instability on infection resolution, fracture healing, and functional recovery in patients with unstable infected fractures.

METHODOLOGY

This section outlines the design, patient selection criteria, treatment protocols, and outcome measures employed in this study to investigate the role of spinal instability in treating unstable infected fractures. The study was conducted at a tertiary care hospital over a two-year period, involving a total of 55 patients. The methodology follows a structured approach to assess how infection

contributes to mechanical instability, evaluate treatment outcomes, and identify key factors influencing fracture healing and spinal stability.

Study Design: This prospective cohort study was conducted at KMU Institute of Medical Sciences Kohat during June 2022 to January 2023. The study involved 55 patients with unstable infected fractures. Patients aged >18 years, diagnosed with unstable fractures involving infection, and with evidence of spinal involvement based on clinical and radiological assessments were included in the study. Patients with non-infected fractures, fractures without spinal instability, severe comorbid conditions, or those unable to comply with follow-up requirements were excluded.

Data Collection: Demographic data, including age, gender, and relevant medical history, were collected for each patient. Baseline clinical data regarding the location and type of fractures, infection site, and any underlying conditions, such as diabetes or immunosuppression, were also documented. The treatment protocol for all patients was personalized to individual needs based on the fracture location, degree of instability, and extent of infection. Initial management involved stabilizing the fracture using external fixation or splinting to prevent further movement and reduce soft tissue damage. If the fracture involved spinal structures, the stabilization aimed to prevent additional neurological compromise. Surgical debridement was performed to remove infected or necrotic tissue, followed by lavage of the wound to minimize the bacterial load. Antibiotic therapy was initiated empirically using broad-spectrum antibiotics and later adjusted according to microbiological culture results. Antibiotics were administered intravenously for the first few weeks, after which oral antibiotics were introduced based on the patient's response. After infection control was achieved, fracture stabilization was undertaken, often involving internal fixation with plates, screws, or rods, depending on the level of spinal instability and fracture severity. Functional outcomes were measured using validated tools such as the Oswestry Disability Index (ODI) for lumbar fractures. This index evaluates pain, mobility, and the ability to perform daily activities. Patients were followed up initially at two-week intervals during the first two months post-surgery, after which follow-up visits occurred monthly for up to one year.

Statistical Analysis: Data were analyzed using SPSS v26. Descriptive statistics were calculated to summarize patient demographics, baseline clinical characteristics, and outcome measures. Continuous variables, such as age and fracture healing times, were analyzed using t-tests. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 55 patients were added in the study, with a mean age of 45.6± 12.4 years, with a male-to-female ratio of 63.6% to 36.4%. The most common fracture locations were the thoracolumbar spine (42%) and cervical spine (27.3%). The majority of patients had osteomyelitic infections (72.7%), with 18.2% having diabetes mellitus and 14.5% having hypertension. Surgical debridement and fixation were the primary treatment for 72.7% of patients, while 27.3% received non-surgical antibiotic therapy. The average BMI was 27.5, with 21.8% of patients being smokers. Preoperative scores revealed moderate disability, with a mean ODI of 38.5 and a VAS score of 7.8, indicating significant pain and dysfunction.

The spinal stability outcomes revealed that 90.9% of patients achieved a stable spine with no movement at the fracture site, indicating successful fracture stabilization. However, 9.1% of patients experienced persistent instability, requiring revision surgery. Additionally, 3.6% of patients developed mild neurological deficits due to instability.

The mean Oswestry Disability Index (ODI) score decreased from 38.5 preoperatively to 14.2 postoperatively, reflecting a substantial reduction in disability. Moreover, 86% of patients showed significant improvement in their ODI scores, demonstrating the effectiveness of the treatment in enhancing patient functionality and quality of life following surgery.

The complication analysis revealed an overall complication rate of 18.2%. Infection-related complications were the most common, affecting 12.7% of patients, with 5 patients experiencing persistent infection and 2 patients having postoperative wound infections. Hardware failure was observed in 3.6% of patients, and mild neurological deficits were noted in another 3.6%. Nonunion complications occurred in 9.1% of patients, underscoring the challenges in achieving complete fracture healing in some cases.

Table 1: Demographic and Baseline Characteristics

Characteristic	Value
Total Number of Patients	55
Mean Age (years)	45.6 ± 12.4
Gender Distribution	
- Male	35 (63.6%)
- Female	20 (36.4%)
Fracture Location	
- Cervical Spine	15 (27.3%)
- Thoracolumbar Spine	23 (42%)
- Lumbar Spine	17 (30.9%)
Type of Infection	
- Osteomyelitic Infection	40 (72.7%)
- Soft Tissue Infection	15 (27.3%)
Comorbidities	
- Diabetes Mellitus	10 (18.2%)
- Hypertension	8 (14.5%)
- None	37 (67.3%)
Type of Treatment Initiated	
- Surgical Debridement & Fixation	40 (72.7%)
- Non-surgical (Antibiotic therapy only)	15 (27.3%)
Mean BMI (kg/m²)	27.5 ± 3.8
Smoking Status	
- Smoker	12 (21.8%)
- Non-smoker	43 (78.2%)
Mean Preoperative ODI Score	38.5 ± 7.2
Mean Preoperative VAS (Visual Analog Scale) Score	7.8 ± 1.5

Table 2: Spinal Stability

Spinal Stability Outcome	Number of Patients	Percentage
Stable Spine (No Movement at Fracture Site)	50	90.9%
Persistent Instability (Required Revision Surgery)	5	9.1%
Neurological Deficits (Mild)	2	3.6%
Revision Surgery Due to Instability	5	9.1%

Table 3: Functional Outcomes (Oswestry Disability Index)

Outcome Measure	Preoperative Value	Postoperative Value
Mean ODI Score	38.5	14.2
Percentage of Patients with Significant Improvement (ODI)	86%	

Table 4: Complications

Complication Type	Number of Patients	Percentage
Total Complication Rate	10	18.2%
Infection Complications	7	12.7%
- Persistent Infection	5	
- Postoperative Wound Infection	2	
Hardware Failure	2	3.6%
Neurological Deficits (Mild)	2	3.6%
Nonunion Complications	5	9.1%

DISCUSSION

The findings of this study provide valuable insights into the role of spinal instability in the treatment of unstable infected fractures. The research evaluated the clinical results obtained from 55 patients who had different levels of spinal instability and infections in their fractures. The research findings stress both the necessity to resolve early infections and create effective fracture healing together with spinal stability preservation to achieve optimal

recovery of function. These findings will be reviewed within their established context through comparisons to other published research and we will discuss the practical treatment consequences of these results. The infection resolution we detected in our research at an 87.3% rate matched findings in studies that established successful fracture healing depends on infection resolution[11]. The healing of bones along with clinical results in spinal fractures depends heavily on infection resolution levels. The management of spinal fractures becomes complicated when infections develop particularly osteomyelitis thus creating both longer recovery periods and increases nonunion risks. The research shows early infection control executed through both surgical debridement combined with antibiotic therapy dramatically increases the healing potential of fractures as documented in[12].

Our treatment succeeded in healing 90.9% of fractures which matches the success levels from previous studies on spinal bony union. The anatomy of cervical spine coupled with its increased movements creates elevated mechanical forces on fracture sites[13]. The occurrence rate of nonunion and complications documented in cervical spine fractures exceeds that of thoracolumbar and lumbar fractures based on research findings. Spinal stability developed in 90.9% of our patients according to our findings because it reduces the likelihood of both spinal deformities and neurological complications[14]. Successful fracture healing together with minimal risk of additional spinal deformities like kyphosis or scoliosis occurs when spinal alignment remains stable. There was a powerful connection between spine stability outcomes and functional recovery because patients who reached spinal stability achieved substantial functional improvement in Oswestry Disability Index (ODI) scores[15]. Postoperative ODI scores demonstrated optimal improvement following the healing of fractures and stabilization of spines in patients because research has already proven these parameters' positive effects on functional outcomes. The ODI serves as an important clinical tool to evaluate therapeutic outcomes in patients who suffer spinal fractures[16]. Our research demonstrates that complete fracture healing together with stable spinal alignment produces significant functional improvements that should guide medical decisions for treating such patients[17]. Among the study participants the rate of complications reached 18.2% and these results fall within the established range recorded for complex spinal fractures involving infection in research literature. Infection appeared as the main complication in 12.7% of patients according to our cohort data yet stays consistent with existing studies emphasizing infection as the primary problem in spinal fracture management particularly when instability occurs. The continuous infection together with prolonged antibiotic treatment or supplemental surgery generated delays in healing and extended medical facility stays for patients. The retrospective study design introduces several limitations because it leads to selection biases along with incomplete dataset collection. The results require verification through future prospective research utilizing bigger patient cohorts because the current study used a diverse group of participants.

CONCLUSION

It is concluded that spinal instability plays a crucial role in the management and treatment outcomes of unstable infected fractures. The study demonstrates that early infection resolution and adequate spinal stabilization significantly contribute to successful fracture healing and improved functional recovery. Patients with stable spines showed significant improvements in both fracture healing and functional outcomes, as measured by the Oswestry Disability Index (ODI).

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