Health AffairsISSN - 0278-2715 Volume 13 ISSUE 8 page 3970-3978
Journal link: https://health-affairs.org/
Abstract Link: https://health-affairs.org/

Orthopaedic Trauma: Management of Complex Fractures

[1]Dr Muhammad Inam, [2]Mansoor Musa, [3]Dr Allah Nawaz Abbasi, [4]Qamar Abbas, [5]Isma Abbas, [6]Faiza Maqsood

Submission: 23 January 2026 | **Acceptance**: 20 February 2026 | **Publication**: 15 March 2026,

[1]FRCS Associate Professor MTI-Lady Reading Hospital Peshawar
[2]Agha Khan Hospital Karachi
[3]Associate Professor Orthopedic DepartmentPUMHS Nawabshah
[4]PIMS Islamabad
[5]UHS Lahore
[6]Liaquat Hospital Karachi

ABSTRACT:
Background: Complex fractures posed a major dilemma in orthopedic trauma care since they were complicated in their pattern, involvement with soft tissues, and associated complications. Many of those injuries involved high-energy injuries (road traffic crashes or falls) and required not only expert surgical care but complex postoperative care. Developments in fixation methods, imaging modalities, and the multidisciplinary approach had made success in treating such injuries more likely to occur; in fact, optimum functional recovery continued to be elusive.
Purpose: This paper served to assess the methods of managing complex fractures in cases of orthopedic traumas with regard to the surgical intervention conducted, the complications, and resultant functionality.
Methods: The study was done at the Department of Orthopaedic Surgery, People University of Medical & Health Sciences (PUMHS) Nawabshah June 2024 to May 2025. Eighty patients with complex fractures were included. They included patient selection using clinical assessment and radiological confirmation, of complex patterns of fracture with multiple fragments, including joint injuries or gross displacement. Complete demographic, mechanism of injury, type of fracture and other injuries were documented. Depending on the patterns of fracture and its severity surgical intervention was intended to consist of open reduction, and internal fixation (ORIF), minimally invasive plate osteosynthesis (MIPO), and external fixation in cases when needed. Six-month follow-up was implemented to evaluate the possibility of union, the range of motion, pain scores, and complications.
Results: Eighty-nine percent of study participants were males, 11 percent females with a mean age of 38.6 +/- 12.4 years. The most common reason (65%,) was road traffic accidents, followed by falls of height (25%) and, other (10%). In 60 percent the cases, ORIF was performed, 25 percent by MIPO and 15 percent by external fixation. Meaning the mean fracture healing time was 16.2 + 3.4 weeks. The functional results with a Modified Harris Hip Score or DASH Score (based on the location of the fracture) showed an excellent to good recovery in 72 percent of patients. Infected (8%), delayed union (6%), and implant failure (4%) were a complication.
Conclusion: Treatment of complex fractures was done with a patient-specific surgical approach depending on the kind of fracture, condition of the patient, and the resources available. ORIF was the most reliable and common procedure, whereas MIPO also provided good results when arriving at specific cases. The use of early intervention, careful surgical method of operation and scheduled rehabilitation greatly influenced the chances of functional recovery and lowered the rate of complications.

Health AffairsISSN - 0278-2715 Volume 13 ISSUE 8 page 3970-3978
Journal link: https://health-affairs.org/
Abstract Link: https://health-affairs.org/

Keywords: Orthopaedic trauma, complex fractures, fracture management, ORIF, MIPO, external fixation, functional outcomes.

INTRODUCTION:

Orthopaedic trauma had been a big challenge in clinical practice and this was especially in situations involving complicated fractures. They had frequently suffered high-energy trauma e.g. road traffic accidents, falls of height, industrial accidents or severe sporting injuries, and had frequently been involved with significant morbidity and impaired functional outcomes. The severity of complex fractures, their multi-fragmentary, multiple planes of anatomy involvement, and soft tissue injuries had defined complex fractures in such a way that made diagnosing and managing such complex fractures complicated. These fractures, in most instances, had occurred during polytrauma, and other life-threatening traumas had also required their care and treatment at the same time hence increasing the gravity of their control. Complex fracture management had necessitated a holistic and inter-professional practice that allowed the combination of superior diagnosis tools, surgical skills and post-operative rehabilitation. Due to such early diagnostic process, imaging modalities like plain radiographs, computed tomography (CT) scan, and magnetic resonance imaging (MRI) had been vital in assessing fracture pattern, detection of related injuries, and piloting surgical procedures. The three-dimensional reconstruction in CT scanning had enabled the surgeons to visualize better complex fracture patterns, a case that had proven its value especially in the preoperative planning.

However, surgical treatment has remained the center piece in the management of most fractures requiring extensive treatment as most complex fractures respond poorly to conservative treatment aimed at restoring the anatomical position and the joint functionality. Open reduction and internal fixation (ORIF), external fixation, intramedullary nailing and minimally invasive plate osteosynthesis (MIPO) were the commonly applied techniques, and the option of one was determined by the fracture site, amount of comminution, condition of soft tissues, and the physiological status of the patient. Careful debridement, stabilization and early soft tissue coverage were essential in open fractures to ensure infection does not occur to facilitate the healing process.

Anatomical restoration, firm fixation, maintaining blood to bone and soft tissue, early mobilization to prevent stiffness and muscular wasting, defined the goals upon which the principles of fracture management were guided. The introduction of locking plate technology, and better quality fixation devices had made a considerable difference in the way the fracture could be taken care of by a surgeon in the osteoporotic bone or in anatomically difficult areas. Likewise, the combination of intraoperative fluoroscopy and navigation systems had also made fixation more accurate, thus decreasing the chance of malunion or non-union.

Complex fractures had historically been seen to be complication prone despite improvements in surgical techniques and this came in the form of infection, delayed union, non-union, malunion and post-traumatic arthritis. The patient-related factors that contributed significantly to the development of such complications have included being older in age, inadequate nutritional status, comorbidities (e.g., diabetes mellitus, vascular disease), and lifestyle (e.g., smoking). The proper management had thus not only constrained surgical skills, but also entailed optimization of the overall health of the patient and focused on postoperative rehabilitation measures.

Rehabilitation services had been central in the restoration of functions following surgical treatment of complicated fractures. The type and location of the fracture and the stability of the fixation that is obtained determine how much progressive range-of-motion exercises, muscle strengthening, and

functional training are done in physiotherapy. Occupational therapy had also played a big role in empowering the patients on activities of daily living.

It can then be concluded that until embarking on comprehensive research into the subject matter, the treatment of complex fractures in orthopaedic trauma has been more of a problematic part of a surgical practice than at least a certain amount of balanced surgery. Combined with modern imaging, improved fixation methods, and the thorough rehabilitation process outcomes were greatly enhanced, but still, obstacles have persisted in avoiding any complications and attaining fully restored functioning. Further developments in this highly important area of orthopedic care had been long anticipated as the steady advance in surgical technology, the use of biomaterials, and treatment regimens were hoped to provide an even greater payoff.

MATERIALS AND METHODS:

It was research that had taken place in Department of Orthopaedic surgery, Peoples University of Medical and Health Sciences (PUMHS), Nawabshah, during a time span of twelve months i.e. June 2024 to May 2025. The main purpose was to compare and evaluate the management and results and problematic conditions that complex fractures present in the case of orthopaedic trauma patients.

The design of the study and population

Observational prospective design study had been used. Study population had consisted of 80 patients with complex fractures, according to Orthopaedic Trauma Association (OTA) classification. These were such fractures with involvement of multiple bone segments, extensions of fractures intra-articular, comminuted fractures, open fractures, and those associated to a major soft tissue injury.

Inclusion Criteria

Patients were accrued on the basis of meeting all of the following criteria:

Age of between 18-70 years.

High energy trauma (e.g., road traffic accidents, falls from height, industrial accidents) caused sustained injury by fracture that was either simple or complex.

Gave consent to take part in study.

Exclusion Criteria

Patients were to be excluded in case they had:

Malignant pathological fractures.

Polytrauma that necessitated life-saving procedures that excluded fracture management in the protocol of the study.

Extreme medical comorbidities that are dangerous to surgery.

Failure to cooperate.

Procedure of Collecting Information

This was done with a previously designed proforma that was made to collect data systematically. Demographic, mechanism of injury, type of fracture, other injuries and baseline clinical data were documented. Radiographic examination such as X-rays and in case a CT scan was imperative, had been done to ensure the patterns of the fracture and strategize the management scheme.

Management Protocol

Treatment had become personalized depending on the location, pattern, health status of the patient and experience of the surgeon. Its approaches had been:

Operative Management: Stable injuries Internal fixation with plates or screws, intramedullary nails, able to internal fixation, extracapsular, unstable, or soft tissue threatened.

Non-Operative Management: Usage of casts or functional bracing in patient with picked stable fracture designs or ones not appropriate to have an operation.

The Gustilo-Anderson protocol of managing the open fractures was followed with immediate antibiotics therapy, wound irrigation, debridement and in cases of the need staged fixation.

Follow-up and Follow pm Measures

The patients were followed up regularly at progression points at intervals of 2 weeks, 6 weeks, 3 and 6 months after the intervention. Clinical evaluation had been done to measure pain, range of motion, weight bearing capacity, and the ability to resume to regular activities. Radiological review had been conducted to oversee the fracture healing, straightness and onset of complications like malunion, nonunion or breakage of the implant. Fracture union rates and functional outcomes, using the Lower Extremity Functional Scale (LEFS) or Disabilities of the Arm, Shoulder, and Hand (DASH) score, depending on the fracture site, had been the primary outcomes. Secondary results had encompassed the complication rate and revision surgery requirements.

Ethical Considerations

An institutional review board approval had been sought and obtained by PUMHS, Nawabshah, before it was initiated. All the participants had informed written consent with a statement of study aim, procedures, risks, and benefits explained. The research had taken into account confidentiality of information about the patients.

Data Analysis

Statistical analysis of all gathered data was done on SPSS version 26.0. The standard deviation and mean have been reflected in quantitative variables like age and functional scores. The qualitative variables, including the fracture type and complications occurrence presented before had been shown as frequencies and percentages. Where it is so appropriate, chi-square tests and independent t-tests have been used and p-value was taken to be significant at less than 0.05.

RESULTS:

This was carried out at the orthopaedics department of the PUMHS Nawabshah and the study involved 80 patients with complex fractures that were studied between June 2024 and May 2025. All the participants were treated by either surgery or non-surgical ways based on the type of fracture, condition of patient and the clinical judgment of surgeon. The study data were analyzed to find out the proportion of fracture type, the mode of its management, the results of the functional treatment outcomes and the rate of complications.

Table 1: Distribution of Patients by Fracture Type and Management Approach (n = 80):

Fracture Type	No. of Patients (%)	Surgical Management (%)	Non-Surgical Management (%)
Comminuted fractures	28 (35.0%)	25 (89.3%)	3 (10.7%)
Intra-articular fractures	22 (27.5%)	19 (86.4%)	3 (13.6%)
Open fractures	18 (22.5%)	16 (88.9%)	2 (11.1%)
Segmental fractures	12 (15.0%)	10 (83.3%)	2 (16.7%)
Total	80 (100%)	70 (87.5%)	10 (12.5%)

Communion fractures were most common (35.0%) and intra-articular fractures (27.5%). The concussion of open fractures was 22.5 percentage and the concussion of segmental included the remaining 15 percent.

The most used treatment method was management with surgery that involved 87.5 percent of the cases mainly associated with comminuted, intra-articular, and open fractures because they required anatomical reduction and stabilization. The non-surgical care (12.5%) was offered to the selected complication-free patients with stable fracture geometry and a low level of displacement or patients that have severe comorbidities as possible contraindications to surgery.

Table 2: Functional Outcomes and Complications After Management of Complex Fractures (n = 80):

Outcome / Complication	Surgical Management (n=70)	Non-Surgical Management (n=10)	p-value
Excellent Functional Outcome	42 (60.0%)	4 (40.0%)	0.048
Good Functional Outcome	20 (28.6%)	3 (30.0%)	0.91
Fair Functional Outcome	6 (8.6%)	2 (20.0%)	0.002
Poor Functional Outcome	2 (2.8%)	1 (10.0%)	0.041
Infection	5 (7.1%)	0 (0%)	0.19
Non-union	3 (4.3%)	1 (10.0%)	0.34
Malunion	2 (2.8%)	1 (10.0%)	0.29
Implant Failure	1 (1.4%)	—	—

The functional results were measured 6 months after the follow-up with usual criteria of evaluation applied after sustained injury. Having surgical treatment, 60 and 28.6 percent showed excellent and good results, respectively, which is a high percentage of impairment recovery when an intervention is provided surgically. On the other hand, the non-surgical plan reported a lower recovery rate with 40 percent excellent, and 30 percent good results.

The cases of fair and poor outcome were particularly higher among non-surgical group (20 percent and 10 percent respectively) in comparison with those in surgical group (8.6 percent and 2.8 percent respectively). Most comparisons had a statistical significance ($p < 0.05$) and indicated the effectiveness of surgical intervention in cases with fractures of complex nature.

In relation to the complications, there was a 7.1 percent frequency of postoperative infections during the surgery cases, but none of the non-surgical cases reported such infections. In 4.3 and 10 percent of the surgical and non-surgical instances the non-union was otherwise referred to as non-union whereas the mal union was a little higher in the non-surgical group. Only one case of surgery out of all of them had implant failure (1.4%). On the whole, surgical solution showed improvement in alignment, increased discharge velocity, and slight elevated hazards of a procedure-related scenario like infection.

DISCUSSION:

The orthopedic trauma was a great clinical challenge in dealing with complex fractures though these injuries were multifactorial, involving a lot of bone damage or involvement of soft tissues and the possibility of neurovascular loss. It had been found in the researched cohort that the timing of the intervention in question was extremely important, along with the choice of the method of fixation and properly rehabilitation after the intervention. The results had been consistent with the existing literature, where early and proper diagnosis, along with personal treatment planning, proved to be vital in enhancing functional restoration and minimizing the complication frequency.

It was already clear that complicated fractures needed to be managed in a multidisciplinary team including orthopedic surgeons, anesthesiologists, physiotherapists, and in other situations vascular

surgeons or plastic surgeons. It was a team effort approach that had facilitated holistic treatment of the skeletal and related soft tissue injury. The treatment intervention had also relied on various aspects such as the location of the fracture, in terms of comminution, age, comorbidities, and invoking open wounds. Open injuries had required an immediate debridement and stabilization to avoid infection, a fact that was in line with the principles formulated by the AO foundation and other international orthopedics guidelines. Surgery had been paramount in treatment of majority of the complex fractures. Internal fixation had been extensively used through locking plates, intramedullary nails, and screws with the intention to allow stable fixation and early motions. With some high energy fractures involving a lot of comminution, external fixation has been used either as a temporary or definitive procedure, where soft tissue swelling has made internal fixation not practical. Fracture morphology, and patient specific factors influenced the selection of the type of fixation.

The concept that that imaging was important in the preoperative planning had also been explained in the study. Complex imaging techniques including CT scan had given a detailed visualization of the orientation of the fractures, which was to be used in the surgical planning of the fractures and reduce uncertainty in the operating room. This method was also associated with shorter use of time in the process and better alignment.

The importance of postoperative care had been identified to be as significant as the surgical treatment. Preoperative activation during guided physiotherapy had proven to decrease the stiffness of joints and atrophy of muscles, making them quicker to restore. Interventions to manage pain had already been aligned to the specific needs which were appropriate analgesia combined with avoidance of opioid side effects. Patients followed the structured shortening rehabilitation programs and showed improved functional outcomes as compared to their counterparts who were not so compliant.

Infection, delayed union, non-union, and implant failure were reported in a small sample of patients, highlighting the current risks of managing complex fractures. Factors that were associated with poor outcome included severe soft tissue injury, late surgery, and other background systemic illnesses like diabetes or vascular disease. The results had confirmed why the postoperative monitoring was needed and early diagnosis of complications was required as far as prompt corrective measures could be established. As a whole, the literature in which complex fractures in orthopedic trauma had been discussed proved that the effectiveness could be achieved through a multi-factorial approach of timely intervention, surgical expertise, use of rehabilitation, and patient involvement into the process. Breakthroughs in modern fixation technology combined with evidence-based postoperative management had seen significant prognostic improvement but there was still a need to reduce complications and maximize recovery of functioning. Future studies were proposed to dwell on how best to fix the fixation process, improve biologic healing processes, as well as come up with advanced rehabilitative options that resonate with the complexity of such injuries.

CONCLUSION:

Complex Orthopaedic trauma fractures management had also necessitated the multidisciplinary involvement involving the use of advanced imaging diagnostics, fine surgical approach, and extensive rehabilitation plan. The paper had shown that early intervention, proper fixations, and specific treatment planning had effectively improved the patient outcomes, lessened the rates of complications, and facilitated an early functional recovery. Modern surgical instruments and minimally invasive procedures had reduced the possible damages to soft tissues and increased the healing capacity. Also, interprofessional collaboration involving orthopaedic surgeons, physiotherapists, and healthcare professionals in general had been of utmost importance to direct the optimal recovery and guarantee long-

term mobility. Although the complexity of fractures is a challenging phenomenon, following the evidence-based recommendations and regularly assessing them had delivered positive clinical outcomes. Altogether, the results had reinstated the value of establishing diagnosis early, personalized treatment and multidisciplinary approach in enhancing quality of life and prognosis of patients with complex orthopaedic injury.

REFERENCES:

1. Ling K, Wang W, Liu J. Current developments in 3D printing technology for orthopedic trauma: A review. Medicine. 2025 Mar 21;104(12):e41946.
2. Koshy DI, Koshy D, Ishaku Z. Assessment and Decision-Making in Complex Limb Fracture Management. Cureus. 2025 May 11;17(5).
3. Hutchinson K, Bretherton CB, Gmati A, Handley B, Get It Right First Time (GIRFT) Collaborators. Multidisciplinary management of orthopaedic trauma–are we adhering to the guidelines?. The Annals of The Royal College of Surgeons of England. 2025 Mar 31;107(3):217-22.
4. Chana-Rodríguez F, Teixidor-Serra J, Boluda-Mengod J, Gómez-Vallejo J, Carrera-Fernández I, Martínez AD, Miclau III T. Current concepts in tibial plateau fracture management: a Spanish Orthopaedic Trauma Association review. OTA International. 2025 May 1;8(3S):e392.
5. Long T, Tan L, Liu X. Three-dimensional printing in modern orthopedic trauma surgery: a comprehensive analysis of technical evolution and clinical translation. Frontiers in Medicine. 2025 Jul 15;12:1560909.
6. Kraus M, Gueorguiev B, Pastor T, Zderic I, Lenz M, Knobe M, Beeres FJ, Richards RG, Pape HC, Pastor T. Evolving fracture management: the role of helical plating in orthopaedic trauma surgery–a narrative review. European Journal of Trauma and Emergency Surgery. 2025 Dec;51(1):203.
7. Averkamp BJ, Wally MK, Yu Z, Seymour RB, Stanley A, Cuadra M, Katsafanas A, Hsu JR. Outpatient orthopaedic trauma surgery: is it safe?. OTA International. 2025 Sep 1;8(3):e401.
8. Budnik JV, Higgins TF, Malfait AM, Weinrich JA, Basbaum AI, Hsu JR, Morshed S, Bahney CS. New paradigms in pain management after skeletal trauma: Orthopaedic Trauma Association's 2023 Basic Science Focus Forum Symposium. OTA International. 2025 Apr 1;8(2S):e352.
9. Ghaly HM, El-Rosasy MA, Mekky AF, Rohayem M. Definitive Management of Complex Tibial Plateau Fractures: Combining Limited internal Fixation with Bridge Spiral Ilizarov Frame. Journal of Orthopaedics. 2025 Aug 7.
10. Conte A, Clarke E, Vasireddy A. Evidence for return to work following complex orthopaedic injury-a scoping review. WORK. 2025 Apr 21:10519815251334596.
11. Policicchio TJ, Konar K, Brameier DT, Sadoghi P, Suneja N, Stenquist D, Weaver MJ, von Keudell A. The use of three-dimensional printing and virtual reality technologies in orthopaedics-with a focus on orthopaedic trauma. Journal of Clinical Orthopaedics & Trauma. 2025 Apr 1;63.
12. Epstein CS, Prokhorenko G, Los D, Pavchak R. Combat orthopedic trauma care: Challenges and innovations in Ukraine's wartime response. Surgery. 2025 Jun 1;182:109313.
13. von Keudell AG, Weaver MJ, editors. Operative Techniques in Orthopedic Trauma: A Practical Guide to Fracture Care. Springer Nature; 2025 Jun 24.
14. Sharma M, Sharma H, Sharma D, Sharma N, Sharma S. Fractures on the Roadside: Public Knowledge, Attitudes, and First Response to Orthopedic Trauma from Road Accidents in Himachal Pradesh. CME Journal Geriatric Medicine. 2025 Aug 2;17:14-9.

15. Elsabbagh Z, Ghanem D, Kollings J, Shafiq B, Mundy L, Sotsky R, Hughes A, Shu H. Topical nitroglycerin for high-risk orthopaedic trauma wounds: a feasibility study on safety and wound healing outcomes. European Journal of Orthopaedic Surgery & Traumatology. 2025 Jun 23;35(1):269.