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Trauma and Contemporary Strategies in Fracture Management: A Comprehensive Review

Laura J. Bennett*

Division of Trauma and Musculoskeletal Sciences, University of Toronto, Canada

Review Article

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***For Correspondence**

Laura J. Bennett, Division of Trauma and Musculoskeletal Sciences, University of Toronto, Canada

E-mail: laura.bennett@utoronto.ca

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ABSTRACT

Fractures represent one of the most common musculoskeletal injuries encountered in clinical practice, contributing significantly to morbidity, disability, and healthcare burden worldwide. Effective fracture management is essential to restore anatomical alignment, preserve limb function, and minimize complications such as malunion, non-union, and infection. Over the past few decades, advancements in imaging techniques, surgical fixation devices, and rehabilitation protocols have significantly improved patient outcomes. Fracture management involves a systematic approach beginning with emergency stabilization, accurate diagnosis, classification, and selection of appropriate treatment modalities, including conservative or surgical interventions. This review discusses the principles, classification systems, diagnostic evaluation, conservative and operative management strategies, complications, and recent advances in fracture care. Emphasis is placed on evidence-based practices and multidisciplinary approaches that optimize healing and functional recovery.

Keywords

Fracture management, orthopedic trauma, bone healing, internal fixation, external fixation, rehabilitation, closed reduction, open reduction, musculoskeletal injury

INTRODUCTION

Fractures are defined as a partial or complete disruption in the continuity of bone structure. They occur due to trauma, repetitive stress, or underlying pathological conditions that weaken bone integrity. Globally, fractures contribute significantly to emergency department visits and orthopedic admissions. High-energy trauma, such as road traffic accidents, and low-energy injuries in osteoporotic patients represent the two major causes.

The primary goals of fracture management are anatomical alignment, stable fixation, pain relief, early mobilization, and prevention of complications. According to orthopedic principles, early and appropriate management greatly influences long-term functional outcomes.

Classification of Fractures

Proper classification is essential for guiding treatment decisions.

1. Based on skin integrity

- Closed fractures
- Open (compound) fractures

2. Based on fracture pattern

- Transverse
- Oblique

- Spiral
- Comminuted
- Greenstick (common in children)

3. Based on stability

- Stable fractures
- Unstable fractures

4. Based on etiology

- Traumatic
- Pathological (e.g., tumor, osteoporosis)
- Stress fractures

Understanding fracture patterns helps determine mechanical stability and treatment strategy.

Pathophysiology and Bone Healing

Bone healing is a complex biological process involving inflammation, repair, and remodeling phases.

1. Stages of bone healing

- Inflammatory phase – hematoma formation and cytokine release
- Reparative phase – callus formation (soft and hard callus)
- Remodeling phase – restoration of normal bone structure

Mechanical stability and adequate blood supply are essential for optimal healing.

Clinical Assessment of Fractures

A systematic evaluation includes:

1. History

- Mechanism of injury
- Time of injury
- Associated trauma

2. Physical examination

- Pain, swelling, deformity
- Loss of function
- Neurovascular status

3. Imaging

- X-ray (first-line)
- CT scan (complex fractures)
- MRI (soft tissue involvement)

Radiological evaluation plays a crucial role in fracture confirmation and treatment planning.

Principles of Fracture Management

The core principles include:

- Reduction of fracture fragments
- Maintenance of reduction
- Restoration of function
- Prevention of complications

These principles are fundamental to modern orthopedic trauma care.

Conservative Management

Non-surgical treatment is appropriate for stable and minimally displaced fractures.

1. Methods

- Closed reduction
- Casting (plaster or fiberglass)
- Splinting
- Traction

2. Indications

- Stable fractures
- Pediatric fractures
- Patients unfit for surgery

3. Advantages

- Low cost
- Avoids surgical risks
- Minimal infection risk

4. Limitations

- Prolonged immobilization
- Joint stiffness
- Risk of malalignment

Surgical Management

Surgical intervention is indicated in unstable, displaced, or complex fractures.

1. Types of surgical fixation

- Internal fixation
- Plates and screws
- Intramedullary nails
- Kirschner wires
- External fixation

Used in open fractures and polytrauma cases

2. Indications

- Open fractures
- Intra-articular fractures
- Polytrauma
- Failed conservative treatment

Surgical fixation ensures anatomical alignment and early mobilization, improving functional outcomes.

Management of Open Fractures

Open fractures require urgent intervention due to high infection risk.

Key steps

- Early antibiotic administration
- Surgical debridement
- Stabilization (external fixation)
- Soft tissue coverage

Open fractures are primarily soft tissue injuries associated with bone disruption, requiring multidisciplinary management.

Complications of Fractures

1. Early complications

- Hemorrhage
- Infection
- Neurovascular injury
- Compartment syndrome

2. Late complications

- Non-union
- Malunion
- Osteomyelitis
- Joint stiffness
- Avascular necrosis

Early detection is essential to prevent long-term disability.

Rehabilitation and Physiotherapy

Rehabilitation is a critical component of fracture recovery.

Goals

- Restore joint mobility
- Strengthen muscles
- Improve functional independence
- Methods
- Range of motion exercises
- Weight-bearing progression
- Hydrotherapy
- Electrotherapy

Early mobilization reduces complications such as stiffness and muscle atrophy.

Advances in Fracture Management

Modern orthopedic practice has evolved significantly.

1. Biological enhancements

Bone grafting

Growth factors (BMPs)

2. Technological innovations

- 3D printing for implants
- Computer-assisted surgery
- Minimally invasive fixation techniques

3. Regenerative approaches

- Stem cell therapy
- Tissue engineering

These advancements have significantly improved fracture healing outcomes.

Multidisciplinary Approach

Effective fracture management requires collaboration among:

- Orthopedic surgeons

- Radiologists
- Physiotherapists
- Rehabilitation specialists

A team-based approach ensures holistic patient recovery.

CONCLUSION

Fracture management is a cornerstone of orthopedic practice that requires accurate diagnosis, appropriate classification, and individualized treatment strategies. Advances in surgical techniques, imaging, and rehabilitation have significantly improved outcomes. However, successful fracture healing depends not only on medical intervention but also on patient compliance and timely rehabilitation. Future advancements in biologics and regenerative medicine are expected to further enhance fracture care and functional recovery.

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