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IMPROVING DIAGNOSTIC AND TREATMENT STRATEGIES FOR MECHANICAL HAND INJURIES IN PATIENTS

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Abstract

Mechanical hand injuries are among the most common traumatic conditions in orthopedic and emergency practice. Due to the intricate anatomy of the hand, delayed diagnosis or inadequate treatment can result in permanent functional impairment and reduced quality of life. This study aims to improve diagnostic and treatment strategies for mechanical hand injuries through comprehensive clinical assessment, modern imaging techniques, and individualized therapeutic approaches. Early diagnosis, timely intervention, and structured rehabilitation were found to significantly improve functional outcomes.

Keywords: hand injury, mechanical trauma, diagnosis, treatment strategy, hand surgery, rehabilitation, orthopedic trauma.

Introduction

The human hand is a complex anatomical and functional unit critical for daily life, professional activity, and social interaction. Injuries of the hand, including fractures, lacerations, tendon ruptures, nerve injuries, and crush trauma, account for a significant proportion of emergency and orthopedic cases worldwide. These injuries can result from industrial accidents, domestic injuries, road traffic accidents, or sports-related trauma.

Due to the hand's intricate structure, even minor injuries may lead to significant functional loss if not diagnosed and managed promptly. Conventional management approaches, including immobilization, surgical repair, and physiotherapy, have limitations, particularly in complex multi-structure injuries. Consequently, optimizing diagnostic algorithms and treatment protocols is essential to enhance functional recovery, reduce complications, and restore patient quality of life.

The primary aim of this study is to evaluate the current diagnostic and therapeutic approaches for mechanical hand injuries and to develop a structured strategy for improving clinical outcomes.

Materials and Methods

Study Design and Population

A prospective observational study was conducted on patients admitted to the Orthopedic and Trauma Department of Andijan State Medical Institute with mechanical hand injuries between 2022 and 2025. Inclusion criteria encompassed patients with fractures, tendon injuries, nerve trauma, crush injuries, and combinations thereof. Patients with chronic hand conditions or previous hand surgeries were excluded.

Clinical Assessment

All patients underwent systematic clinical evaluation:

1. **History Taking:** Mechanism of injury, time since trauma, occupation, and hand dominance were recorded.

2. **Physical Examination:** Inspection, palpation, assessment of swelling, deformities, skin lesions, and open wounds.

3. **Functional Testing:** Range of motion, grip strength, and dexterity were measured.

4. **Neurovascular Evaluation:** Sensory and motor function of the median, ulnar, and radial nerves; capillary refill time and peripheral pulse assessment.

Imaging

- **X-ray:** First-line imaging for bone injuries.
- **Computed Tomography (CT):** Used for complex fractures and preoperative planning.
- **Ultrasonography:** Applied for tendon and soft tissue assessment.

Treatment Protocol

Treatment decisions were based on the type, severity, and combination of injuries:

- **Conservative Management:** Used for minor fractures, closed soft tissue injuries, or isolated tendon injuries without functional deficit. Involved immobilization, anti-inflammatory medications, antibiotic prophylaxis when indicated, and physiotherapy.
- **Surgical Intervention:** Indicated for open fractures, tendon lacerations, nerve injuries, and crush injuries with significant soft tissue damage. Surgical approaches included tendon repair, nerve reconstruction, fracture fixation (internal or external), microsurgical reconstruction, and skin grafting or flap coverage when necessary.

Rehabilitation

Structured rehabilitation protocols were initiated postoperatively or after immobilization removal. Exercises included passive and active range of motion, strengthening exercises, and functional task training. Patients were followed for 6–12 months to assess functional recovery.

Results

Demographics and Injury Patterns

A total of 152 patients were included in the study, with a male-to-female ratio of 3:1. The mean age was 34.6 ± 12.2 years. Most injuries were caused by workplace accidents (42%), domestic trauma (30%), and road traffic accidents (20%). The most common injury types were:

- Fractures: 55%
- Tendon injuries: 35%
- Nerve injuries: 18%
- Crush injuries: 22% (including combined soft tissue and bone trauma)

Diagnostic Accuracy

Early diagnosis within the first 6 hours post-injury significantly reduced complications. Radiography accurately identified fractures in 98% of cases. CT scans provided essential detail in 20% of complex fractures. Ultrasonography improved detection of tendon lacerations, particularly in zones II and III of the hand.

Treatment Outcomes

- **Conservative Management:** Applied in 46% of cases. Functional recovery was satisfactory, with minor limitations in 12% of patients.
- **Surgical Intervention:** Required in 54% of patients. Tendon repairs, nerve reconstructions, and fracture fixations resulted in improved functional outcomes compared with delayed surgical intervention. Early initiation of rehabilitation post-surgery was critical for restoring range of motion and strength.

The overall complication rate was 8%, including infection (3%), tendon adhesion (2%), and delayed nerve recovery (3%). No cases of permanent major disability were reported.

Discussion

This study confirms that timely and accurate diagnosis, combined with individualized treatment planning, is crucial for optimal recovery from mechanical hand injuries.

1. **Early Intervention:** Prompt evaluation using a structured algorithm ensures early identification of bone, tendon, and nerve injuries, reducing long-term disability.
2. **Imaging:** While X-ray remains essential for bone injuries, CT and ultrasonography complement the assessment, particularly for complex fractures and soft tissue injuries.
3. **Surgical Precision:** Microsurgical techniques and combined tendon/nerve repairs improve functional outcomes in severe injuries.
4. **Rehabilitation:** Early, structured rehabilitation contributes to faster recovery, reduced stiffness, and improved hand function.

A standardized diagnostic and treatment algorithm can serve as a practical guide for clinicians, ensuring comprehensive management and optimal patient outcomes.

Conclusion

Mechanical hand injuries require a multidisciplinary approach involving early diagnosis, precise surgical intervention when indicated, and structured rehabilitation. Implementing a systematic treatment algorithm enhances functional recovery, minimizes complications, and improves overall patient quality of life. Continuous training in modern diagnostic and surgical techniques is essential for optimizing care in orthopedic and trauma settings.

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