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Bony Mallet Finger: A Comparative Review of Approaches in Pediatric vs. Adult Populations

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Abstract

Background: Bony mallet finger injuries result from distal phalanx fracture, often involving avulsion fractures of the distal phalanx. Optimal management remains debated, particularly between pediatric and adult populations.

Objective: This review compares surgical and conservative treatments for acute bony mallet finger fractures, focusing on healing times, functional recovery, and complications.

Methods: A systematic search of PubMed, Scopus, and Cochrane Library (2014–2024) identified studies evaluating treatment strategies in adults and children. Outcomes assessed included healing time, clinical recovery, and complication rates.

Results: Conservative treatment, was preferred in adults, leading to healing times of 6–8 weeks but with a higher incidence of deformities. Surgery, useful in pediatric cases, provided faster recovery and superior functional outcomes. The Ishiguro method in children showed improved extension recovery with shorter immobilization. Surgery in adults led to quicker functional recovery but had higher complication rates. Pediatric surgical cases had a slightly higher risk of growth disturbances, though overall better functional outcomes.

Conclusions: Pediatric patients had superior long-term outcomes regardless of treatment modality. While conservative treatment in adults resulted in prolonged recovery and more deformities, surgery carried a higher complication risk. Both groups showed a favorable prognosis, warranting further research to refine treatment strategies.

Introduction

Bony mallet finger injuries are tendon injuries typically resulting from trauma to the extensor tendon, that lead to the rupture of the tendon accompanied by avulsion fractures at the base of the distal phalanx[1]. Consequently, active extension of the distal interphalangeal (DIP) joint is impaired, causing the finger to present clinically with a characteristic droop[2]. Such injuries significantly affect finger function and are most associated with sports-related trauma, though not exclusively.

The injury mechanism generally involves an axial force applied to the tip of an extended finger, followed by passive and extreme hyperflexion of the DIP joint[3,4]. The overall incidence of mallet finger (both tendinous and bony types) is approximately 10 cases per 100,000 person-years[5]. Of these, around 30% to 50% are classified as bony mallet injuries[6].

Most cases involve closed injuries; however, more complex

traumas, such as those caused by crush injuries or lacerations to the dorsal aspect of the distal phalanx, may result in complete tendon transection with the same clinical results[7]. Mallet finger injuries are broadly categorized into two types: bony mallet injuries and soft tissue (tendinous) mallet injuries, depending on whether or not an avulsion fracture occurs at the insertion of the extensor tendon on the distal phalanx[3].

More specifically Doyle's classification system[8] identifies four main types of mallet injuries: closed injuries (with or without avulsion fracture; Type 1), open injuries with tendon laceration (Type 2), open injuries involving tendon substance and soft tissue loss (Type 3), and mallet fractures (Type 4). Type 4 is further subdivided into three subtypes: transphyseal fractures in children (Type A), hyperflexion injuries involving 20%-50% of the articular surface (Type B), and hyperextension injuries affecting more than 50% of the articular surface (Type C). Although Doyle's classification is one of the most widely used, it is less specific to the acute closed bony mallet discussed here, so reference can be made to Wehbé and Schneider's classification (Table 1)[9].

Bony mallet injuries are more common in younger patients, with a mean age of 40 years, and are generally associated with high-energy trauma[10,11]. Tendinous injuries primarily involve the middle and ring fingers, whereas bony injuries are more commonly seen in the ring and little fingers[9,12].

Although several classifications based on clinical and radiological findings are associated with well-established treatment protocols for closed mallet finger—whether tendinous or bony—there is no clear consensus on whether a distinct management strategy should be adopted for acute bony mallet finger, taking into account the patient's age. Some researchers advocate for immediate surgical intervention[13,14], citing faster functional recovery, while others recommend varying immobilization strategies for the DIP joint in a neutral or slightly hyperextended position[12]. Recently, a decision-making algorithm has proposed nonsurgical management for most mallet finger cases in adults, reserving surgical procedures for cases of failed conservative treatment or inadequate fragment reduction[3]. However, surgical treatment seems to be the most effective approach in children[15].

Table 1: Wehbé and Schneider's classification[9]

Wehbé and Schneider's classification	
Type	**Definition**
I	No DIP joint subluxation
II	DIP joint subluxation
III	Epiphyseal and physeal injuries
Subtype	**Definition**
A	Avulsed fragment <1/3 of articular surface
B	Avulsed fragment 1/3 to 2/3 of articular surface
C	Avulsed fragment >2/3 of articular surface
Abbreviation: Distal Interphalangeal Joint (DIP)	

Despite numerous studies evaluating the outcomes of surgical and conservative treatments, comparative research remains limited. Moreover, previous studies have reported inconsistent results regarding the effectiveness of surgical versus nonsurgical interventions. Consequently, the aim of this study is to summarize the outcomes of surgical and conservative treatments for acute bony mallet finger injuries, with a focus on comparing results between pediatric and adult populations.

Materials and Methods

Study Selection

For this review, studies published in the last 10 years (2014-2024) focusing on the treatment of acute mallet finger bony fractures in adults and children were included. A systematic search was conducted in the following databases: PubMed, Scopus, and the Cochrane Library. The search terms used included "acute mallet finger," "bony fracture," "treatment," "adult," "children," "management," "fracture healing," "surgical treatment," and "conservative treatment." Only studies published in English were considered.

Inclusion Criteria

The included studies had to meet the following criteria:

- Studies on the natural history or treatment approaches for acute bony mallet finger fractures in adults and children.
- Comparisons between surgical and conservative treatments.
- Data on clinical outcomes, healing times, complications, and functional recovery.
- Prospective, retrospective, randomized studies, or case series.

Exclusion Criteria

The following studies were excluded:

- Studies on no-fracture mallet finger (e.g., isolated tendon injuries).
- Case report and case series.
- Non-peer-reviewed articles or non-clinical studies (e.g., case reports without patient series).

Limitations of the Review

Since observational studies were included, the potential for selective bias in data collection was considered a limitation. Additionally, variability in surgical techniques

and treatment protocols could influence the comparative results between the adult and pediatric groups. Despite these limitations, this review provides a useful overview of current treatment modalities for acute bony mallet finger fractures and long-term out.

Results

A total of 350 potentially relevant studies were initially identified through the search. After the titles and abstracts of these articles had been reviewed for relevance, 65 articles remained, and the full text of these articles were evaluated. Ultimately, 26 articles fulfilled the inclusion criteria and were included.

These studies, published between 2014 and 2024, primarily focused on acute bony mallet finger fractures, comparing the outcomes of surgical and conservative treatment modalities.

The pediatric cohort included patients aged between 11 to 17 years, whereas the adult cohort took into consideration individuals older than 18 years. Gender distribution and other demographic variables were comparable across treatment groups in most studies, though some variability was noted in baseline characteristics.

Treatment Modalities

Conservative Treatment

Conservative treatment primarily consisted of splinting in a neutral or slightly hyperextended position for the DIP joint, with variations in duration (ranging from 6 weeks to 8 weeks)[3,16]. Hyperextension aims at bringing both tendon ends into contact to avoid healing with a lengthened callus. Numerous immobilization devices have been described, with a volar bearing[14], a dorsal bearing[17], or a combined dorsal and volar bearing. The majority of adult cases were managed conservatively, with reported healing times of 8 weeks[18]. Pediatrics patients, conversely, should be more likely to undergo surgical intervention[15], though conservative management was still used in some cases.

Surgical Treatment

The most commonly described surgical techniques included trans-DIP joint K-wire fixation and open reduction internal fixation with K-wire[18,19,20]. The most frequently described surgical indications were size of fracture (more than one-third of articular surface involvement) and subluxation of the distal phalanx. Patients requiring fine manual dexterity were also cited as surgical indications[21]. In adults, surgery was typically recommended in cases of non-reducible fractures, comminuted fractures or significant tendon avulsion[22]. Pediatric patients were more frequently treated with surgery due to the nature of bony mallet fractures, with surgery generally providing better functional outcomes. Leti Acciaro et al.[15] effectively demonstrated that the Ishiguro method[23] is an effective and less invasive technique even in children. According to their study, in the pediatric population, the extension block with K-wire allowed for better compliance and a reduction in the immobilization period (5 weeks compared to 6/8 weeks[24]); a high percentage of excellent and good results was achieved with a shorter immobilization period. The method showed a strong statistical correlation in terms of better extension recovery, mainly in relation to the delay in treatment rather than the technique chosen. In all children, the Ishiguro technique facilitated closed reduction and allowed for anatomical realignment of the fracture. The criticism regarding the risk of joint damage due to Kirschner wire fixation was not supported by the study. During surgery, particular care was taken to avoid the extension block with K-wire in hyperextension of the distal phalanx or in flexion fixation. In both univariate and multivariate regression analyses, a strong and linear correlation was described between worse outcomes and the waiting time between trauma and surgery, as well as a strong and linear correlation with an excessive intraoperative flexion angle during fixation.

The Ishiguro technique

The Ishiguro technique is an extension block technique using Kirschner wires for the bony mallet finger. It is performed percutaneously under image intensifier control. In the first step of this procedure, the distal phalanx is in maximum flexion. To support the fracture fragment, a 1 mm diameter Kirschner wire is inserted percutaneously through the terminal extensor tendon, 1.2 mm above the fragment, into the middle phalanx. Another 1 mm Kirschner wire is then inserted to keep the distal interphalangeal joint in extension.

After surgery, the treated finger is immobilized with a Zimmer volar splint with DIPJ and PIPJ blocks. Immobilization is maintained for five weeks and removed at the same time as K-wire removal in the outpatient clinic after radiographic confirmation of calcification. After K-wire removal, patients immediately begin a gradual and progressive active mobilization protocol under the supervision of our physiotherapists. Trauma and sports activities can be postponed for a further four weeks[23].

Clinical Outcomes

Healing Times

The mean healing time for conservative treatments in adults was 6-8 weeks, while surgical treatments led to a mean healing time of 4-6 weeks[3,16]. Although there is no clear evidence in the literature supporting the superiority of the surgical approach in children, it appears to carry a lower risk of malunion or nonunion, likely due to the reduced compliance required, thereby leading to a higher rate of successful outcomes[15].

Complications

The overall complication rate was higher in surgical cases across both groups. In adults, complications such as infection, nonunion, and joint stiffness were reported[22,25]. In pediatric patients, complications such as growth disturbances, delayed union, and malunion have been reported in some surgically treated cases. However, these complications are exceedingly rare when the Ishiguro technique is employed, and no cases of nail dystrophy have been documented. The most frequently observed surgical complication remains localized infection[26]. Conservative management was associated with fewer complications but had a higher rate of finger deformity[21] and longer recovery in some adult cases. In addition, healing of a displaced bone fragment can lead to severe extensor lag, swan-neck deformity, secondary arthritis, and stiffness[9].

Comparative Outcomes: Pediatric vs. Adult Populations

Pediatric patients consistently demonstrated better long-term functional outcomes compared to adults, irrespective of the treatment modality. This difference can likely be attributed to the higher plasticity and healing potential of bone and tendon in younger individuals. In contrast, adult patients, especially those with older age or comorbidities, exhibited a longer recovery period, particularly in cases treated conservatively.

In terms of outcomes, pediatric patients treated conservatively exhibited a lower overall rate of adverse events, suggesting more favorable outcomes with non-operative treatment in younger populations. However, the pediatric cohort showed a slightly higher rate of surgical complications, likely due to the technical challenges of fixation in a growing skeleton. Nevertheless, growth disturbances are extremely rare, and cases of nail dystrophy are virtually absent. Overall, surgical management in pediatric patients appears to yield the best outcomes, with shorter recovery times, despite an increased risk of complications, most of which are limited to local infections at the surgical site.

Summary of Key Findings

- Conservative treatment generally resulted in longer healing times and a higher incidence of deformities in adults compared to surgical interventions.
- Surgical treatment in adults was associated with faster functional recovery, but a higher risk of complications, including infection and joint stiffness.
- In pediatric populations, surgical treatment was the most effective for both healing time and functional recovery, though conservative management showed promising results in terms of fewer complications.

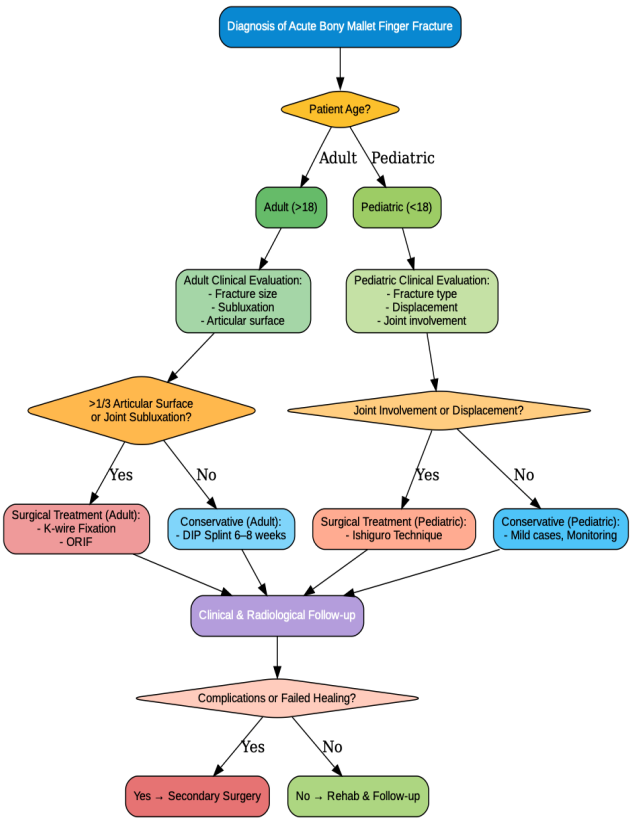

Figure 1: Decision flowchart based on the results obtained

- Despite differences in treatment approaches, both groups showed a good overall prognosis, with the majority of patients returning to their previous level of function.
- Figure 1 shows the decision flowchart based on the results obtained.

Declarations

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No funding or royalties were received for this article.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Informed Consent

Not applicable.

Authors' Contributions

All authors have contributed significantly to, and take public responsibility for, study design and data acquisition, analysis and interpretation. The first draft of the manuscript was written by DG e AP and all authors commented on previous versions of the manuscript. All authors approved the final version of the manuscript.

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Consent for Publication

The authors affirm that human research participants provided informed consent for publication of the images.

Availability of Data and Material (Data Transparency)

Statistical data and analysis available digitally.

Code Availability (Software Application or Custom Code)

Not applicable.

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