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Original Article

MANAGEMENT OF ACUTE BONY MALLET FINGER BY MICRO PLATE FIXATION

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Abstract

Hyperflexion of the distal interphalangeal (DIP) joint or axial tension can cause the extensor terminal band to rupture or the distal phalanx to avulse, leading to Mallet finger. The aim of this work was to evaluate the clinical and radiographic outcomes of bony mallet finger treated with Micro Plate. ***Methods:*** *This randomized prospective clinical trial involved 20 patients with acute bony mallet finger injuries affecting more than one-third of the distal phalanx articular surface or presenting with volar subluxation of the distal phalanx.* ***Results:*** *The study group had a mean age of 35.40 ± 10.04 years and included a higher proportion of males. There were no significant differences among occupations. The group demonstrated mean operative time (40.05 ± 0.83 minutes). Functional evaluation showed Quick DASH score (3.15 ± 0.75, $p < 0.001$), suggesting favorable hand function. Range of motion (ROM) at the MCP, PIP, and DIP joints was well preserved. The mean fracture union time was (6.00 ± 0.46 weeks, $p < 0.001$). Although the complication rate reached 20%, 75% of the patients achieved excellent clinical outcomes ($p = 0.043$), indicating overall effectiveness of micro plate fixation.* ***Conclusions:*** *Micro plate fixation appears to be an effective treatment option for acute bony mallet finger injuries, particularly when the goal is to achieve optimal functional results.*

Keywords: *Acute Bony Mallet Finger, Micro Plate Fixation.*

1. Introduction

Excessive flexion at the distal interphalangeal (DIP) joint or axial tensile forces may result in disruption of the terminal portion of the extensor tendon or avulsion of the distal phalanx, ultimately causing what is known as a mallet finger deformity. In clinical practice, when acute bony mallet finger fractures are diagnosed, surgical fixation becomes necessary particularly when the injury involves one-third or more of the distal phalanx articular surface or when volar subluxation of the distal phalanx is present [1,2]. If left untreated, such fractures may lead to complications including extensor lag and development of swan-neck deformities [3]. Among the various surgical approaches, micro plate fixation has emerged as one of the techniques used to manage acute bony mallet finger injuries [2]. The key advantages of employing the micro plate technique include the ability to achieve precise anatomical reduction and stable fixation. Moreover, it minimizes the risk of further fragmentation of the small dorsal bony fragment and facilitates early mobilization of the finger joints [4,5]. However, premanufactured micro plates are associated with several limitations such as high cost and restricted availability, which may affect their broader application in clinical settings [2,6,7]. Given these considerations, the objective of the present study was to assess both clinical and radiological outcomes following the treatment of acute bony mallet finger fractures using customized micro plate fixation techniques.

2. Patients and Methods

This Prospective randomized controlled clinical trial study was carried out on 20 patients, with acute bony mallet finger involves more than one third of the distal phalanx joint surface or the distal phalanx becomes volar sub laxed. The study was done after approval from the Ethical Committee Sohag University Hospitals An informed written consent was obtained from the patients. Exclusion criteria were crushed distal phalanx, soft tissue mallet, multiple phalangeal fractures and old neglected cases. All patients were subjected to initial evaluation which included history, clinical examination and radiographic evaluation by X-ray Anteroposterior and lateral views. Full preoperative neurological and vascular assessment. Routine laboratory investigation.

2.1. *Surgical technique*

The micro plate used in this procedure was custom-prepared by modifying a standard 1.3-mm AO plate. Specifically, two holes were excised from the body of the plate, and the far-end ring was then cut to create a two-legged configuration. The legs of the ring were subsequently bent at a 90-degree angle to form the hook required for fixation. All surgical procedures utilizing the prepared micro plate technique were conducted under regional anesthesia, either via infraclavicular nerve block or digital nerve block, depending on the case. A longitudinal "S"-shaped incision was made over the DIP joint to gain access. Careful dissection was performed to expose the terminal extensor tendon and the associated fracture fragment while taking particular care to preserve the nail germinal matrix to avoid postoperative nail deformities. After identifying the fracture fragment, reduction was achieved by aligning the bone anatomically. The custom-prepared micro plate was applied such that its hook-like legs were embedded securely into the extensor tendon, allowing it to anchor the bony fragment in position. The plate was then affixed to the distal phalanx using a 1.3-mm cortical screw to ensure stable fixation. Postoperative mobilization was staged: controlled passive joint movements were initiated at three weeks following surgery, and active joint movements were allowed to commence at the fourth week. By the sixth postoperative week, patients were encouraged to begin unrestricted daily finger movements to promote functional recovery.

2.2. *Post-operative evaluation*

Clinical evaluation of improvement of pain, deformity, range of motion (ROM), incidence of surgical site infection, radiographic union time, follow up duration at one month and 3 months duration.

2.3. *Statistical analysis*

Statistical analysis was done by SPSS v25 (IBM Inc., Chicago, IL, USA). Quantitative variables were presented as mean and standard deviation (SD). Qualitative variables were presented as frequency and percentage (%). Shapiro-Wilk test was done to test the normality of data distribution. Chi-Square test used to examine the relationship between qualitative variables.

3. Results

The mean age for study group was 35.40 ± 10.04 years. Study group had a high proportion of males compared to females. Regarding occupation, the distribution of drivers, housewives, manual workers, students, and teachers was with no statistically significant differences ($p = 0.970$), tab. (1). According to the fracture-related data. In terms of the side of the fracture, the left side was involved in 25% of Study group and the right side was involved in 75%, Regarding the site of the fracture, the index finger, little finger, middle finger, and ring finger were similarly involved across the study group, with no statistically significant difference ($p = 0.600$), tab. (2). According to the duration of the operation, Study group has mean operation time of 40.05 ± 0.83 minutes, tab. (3). The mean handgrip percentage was 92.10 ± 1.07% in Study group, with a p-value of 0.649. According to the Quick DASH score data, Study group, treated with micro plate fixation, had mean Quick DASH score 3.15 ± 0.7. Low Quick DASH scores in the study group suggest that this method might be associated with improved daily functional performance, tab. (4). According to the MCP, PIP and DIP joints ROM data, Study group had a mean MCP joint ROM of 94.00 ± 3.00%, Study group had mean PIP joint ROM of 92.55 ± 3.52%, Study group had mean DIP joint ROM of 95.50 ± 1.47%, tab. (5). Study group had a significantly mean union time of 6.00 ± 0.46 weeks. According to the complications data, In Study group, 80% of patients experienced no complications, Specific com-plications in Study group included non-union in 10% of

patients, infection in 5% of patient, and arthritis in 5% of patients. According to the outcome data, Study group, 75% of patients had excellent outcomes, Additionally, 15% of patients in Study group had good outcomes and 10% of patients in Study group had fair outcomes, tab. (6).

Table (1) Demographic data among study group.

		Study Group	Test, p-value
		n=20	
Age (years)	▪ ***Mean ± SD***	35.40 ± 10.04	t: 1.574, p=0.124
	▪ ***Median***	35.00	
	▪ ***(Min-Max)***	(20.00-55.00)	
Sex	▪ ***Female***	2(10.0%)	FE, p=1.000
	▪ ***Male***	18(90.0%)	
Occupation	▪ ***Driver***	3(15.0%)	X2: 0.538, p=0.970
	▪ ***Housewife***	2(10.0%)	
	▪ ***Manual Worker***	10(50.0%)	
	▪ ***Student***	4(20.0%)	
	▪ ***Teacher***	1(5.0%)	

t: *Student t test,* ***X2:*** *Chi square test*

Table (2) Fracture related data in study groups.

		Group A	Test, p-value
		n=20	
Side of Fracture	▪ ***Left***	5(25.0%)	X2: 0.119, p=0.730
	▪ ***Right***	15(75.0%)	
Site of Fracture	▪ ***Index Finger***	4(20.0%)	X2: 1.870, p=0.600
	▪ ***Little Finger***	6(30.0%)	
	▪ ***Middle Finger***	3(15.0%)	
	▪ ***Ring Finger***	7(35.0%)	

X2: *Chi square test,* ***FE:*** *Fissure exact*

Table (3) Duration of intervention among study group

		Group A	Test, p-value
		n=20	
Time from injury to operation (days)	▪ ***Mean ± SD***	1.50 ± 0.61	t: 0.000, p=1.000
	▪ ***Median (Min-Max)***	1.00 (1.00-3.00)	
Time of operation (min)	▪ ***Mean ± SD***	40.05 ± 0.83	Z: 5.410, p<0.001*
	▪ ***Median (Min-Max)***	40.00 (39.00-42.00)	

t: *Student t test,* ***Z:*** *Mann Whitney test*

Table (4) Handgrip and Quick DASH Score among study group.

		Study group	Test, p-value
		n=20	
Handgrip (%)	▪ ***Mean ± SD***	92.10 ± 1.07	Z: 0.446, p=0.649
	▪ ***Median (Min-Max)***	92.00 (90.00-94.00)	
Quick DASH Score	▪ ***Mean ± SD***	3.15 ± 0.75	Z: 3.070, p<0.001*
	▪ ***Median (Min-Max)***	3.00 (2.00-5.00)	

Z: *Mann Whitney test,* ******* *for significant p value (<0.05),* ***DASH****: Disabilities of the Arm, Shoulder, and Hand*

Table (5) MCP, PIP and DIP joints ROM among study groups.

		Study group (n=20)	Test, p-value
MCP joint ROM (%)	▪ Me***an ± SD***	94.00 ± 3.00	t: 1.012, p = 0.319
	▪ ***Median (Min-Max)***	94.00 (88.00-99.00)	
PIP joint ROM (%)	▪ ***Mean ± SD***	92.55 ± 3.52	t: 1.012, p = 0.319
	▪ ***Median (Min-Max)***	91.50 (88.00-99.00)	
DIP joint ROM (%)	▪ ***Mean ± SD***	95.50 ± 1.47	
	▪ ***Median (Min-Max)***	96.00 (93.00-99.00)	t: 0.932, p = 0.359

Table (6) Union Time, complications and Outcome among study group.

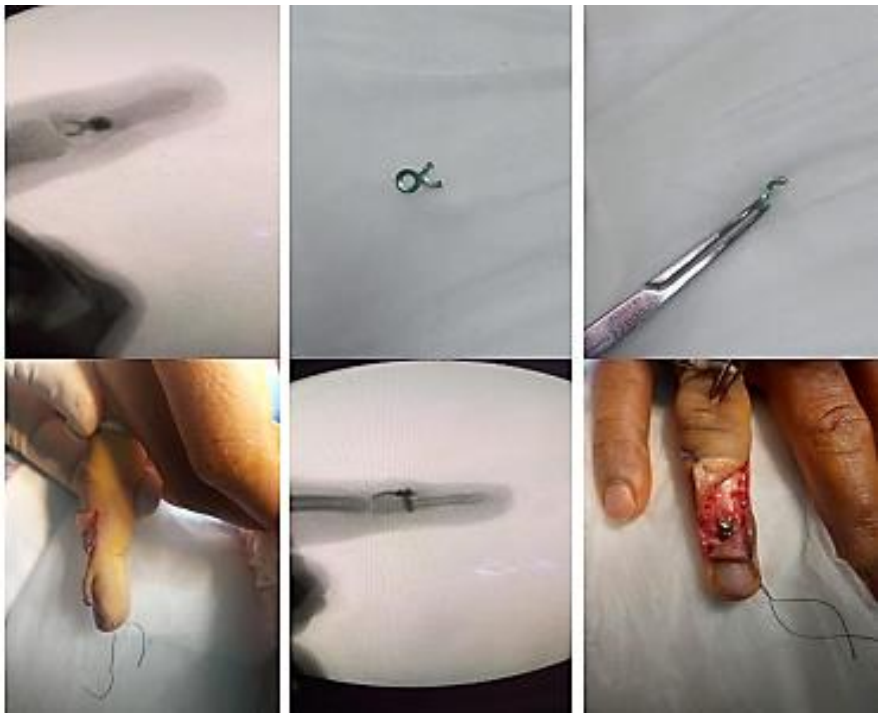
		Study group *n=20*	Test, p-value
Union Time (weeks)	▪ ***Mean ± SD***	6.00 ± 0.46	Z: 5.410, p<0.001*
	▪ ***Median (Min-Max)***	6.00 (5.00-7.00)	
Complications	▪ ***No Complication***	16 (80.0%)	X2: 2.330, p=0.506
	▪ ***Non-union***	2 (10.0%)	
	▪ ***Infection***	1 (5.0%)	
	▪ ***Arthritis***	1 (5.0%)	
Outcome	▪ ***Excellent***	15(75.0%)	X2: 5.070, p=0.079
	▪ ***Fair***	2(10.0%)	
	▪ ***Good***	3(15.0%)	

Z: *Mann Whitney test,* ******* *for significant p value (<0.05),* ***X2:*** *Chi square test*

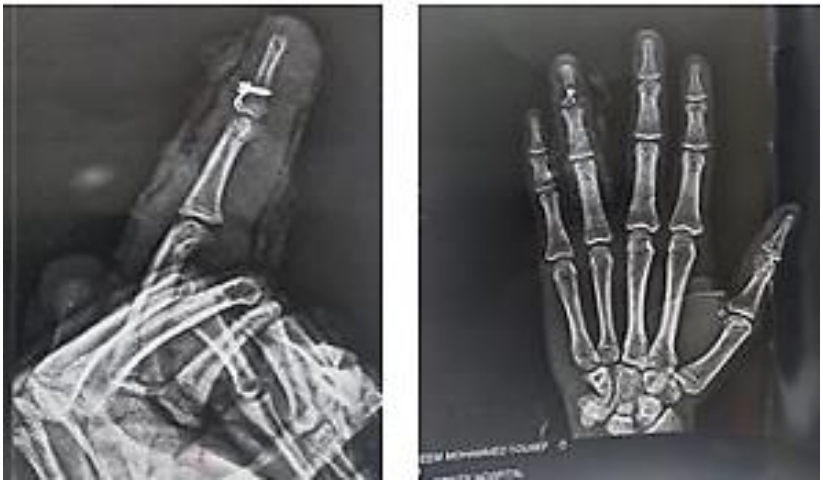
4. Cases

4.1. *Case 1*

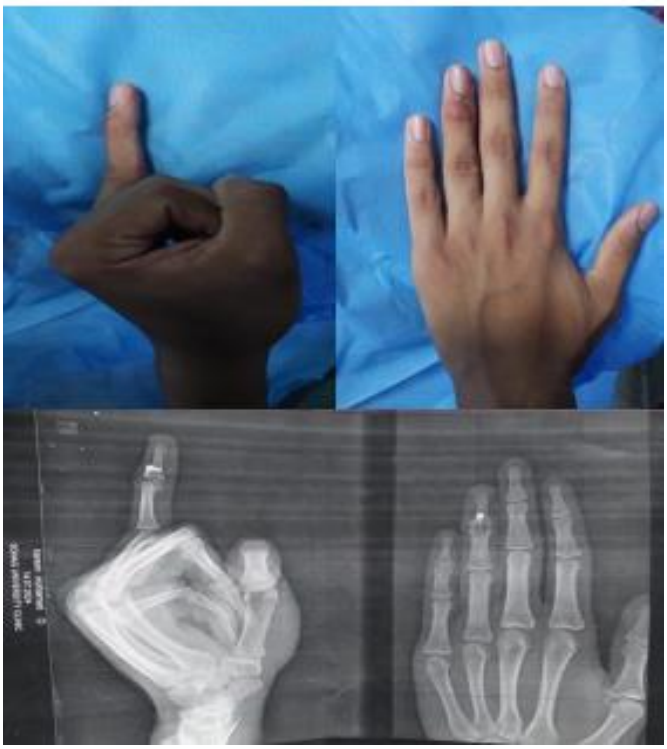
Pre operative



Intra operative



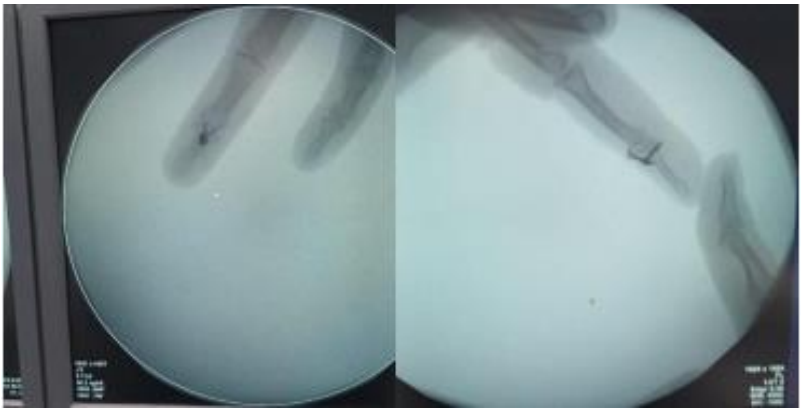
Post operative



Follow up

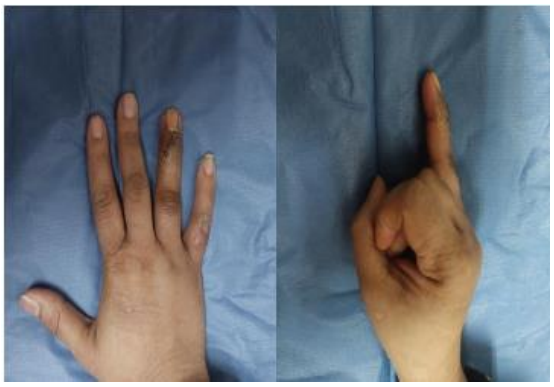
4.2. *Case 2*

Pre operative



Intra operative

Pre operative



Follow up

5. Discussion

Micro plate fixation remains a viable method in the management of acute bony mallet finger injuries [8]. In the current study, the demographic variables and fracture characteristics demonstrated no statistically significant differences, supporting existing evidence that factors such as age and gender do not substantially influence clinical outcomes in mallet finger cases [9]. Comparable findings have been observed in other studies, where patient demographics showed no notable impact on recovery or treatment success [10]. This consistency reinforces the notion that clinical evaluation of therapeutic approaches for bony mallet injuries can proceed without concern for demographic confounding. However, it is worth noting that some studies have reported variations in clinical outcomes depending on the type of intervention, highlighting the complexity of choosing optimal management strategies [11]. With regard to surgical duration, the mean operation time in the study group was at 40.05 ± 0.83 minutes. These findings align with observations made by Song et al. [12], who documented that more complex fixation procedures, such as those involving micro plates, are generally associa-

ted with extended operative times. In contrast, research by Khera et al. [10] presented differing conclusions, suggesting that although micro plate fixation may be more time-consuming, its contribution to fracture stability and post-operative recovery may outweigh concerns over procedural duration. The assessment of hand grip strength revealed a mean percentage of 92.10 ± 1.07% in the study group, with a p-value of 0.649, suggesting that the recovery of grip function following micro plate fixation is satisfactory. Additionally, the Quick Disabilities of the Arm, Shoulder, and Hand (Quick DASH) score—which evaluates hand function and its impact on daily activities—was notably at 3.15 ± 0.75 ($p < 0.001$), indicating favorable functional recovery. These outcomes suggest that micro plate fixation is potentially more effective in restoring hand utility compared to some alternative techniques. The analysis of joint mobility (ROM) further supports the effectiveness of the micro plate method. The study group achieved a mean ROM of 94.00 ± 3.00% at the MCP joint, 92.55 ± 3.52% at the PIP joint, and 95.50 ± 1.47% at the DIP joint, reflecting preserved flexibility and motion post-surgery. A recent comparative study corroborated these findings by reporting similar grip strength outcomes among patients treated with K-wire and other fixation techniques, indicating that recovery of hand strength may not differ significantly between approaches [13]. However, Mittal et al. [14] reported inconsistent results, suggesting that although micro plate fixation may offer structural stability, it could also result in higher Quick DASH scores due to increased surgical complexity or potential complications. Further supporting our findings, a study by BK et al. [15] demonstrated that assessments of active and passive ROM across the MCP, PIP, and DIP joints are reliable, particularly when measurements are performed by a single examiner. This strengthens our results showing consistent ROM outcomes. Conversely, Ahmed et al. [16] found that K-wire fixation often leads to superior functional outcomes and enhanced joint movement, especially in the PIP and DIP joints, when compared to more rigid fixation methods like micro plates. Similarly, Galbraith et al. [17] noted improved finger mobility with K-wire techniques over more invasive procedures, challenging the current study's findings regarding joint flexibility. Despite this, other studies have noted mixed results for micro plate fixation—acknowledging its capacity for stable fixation but also pointing out complications such as joint stiffness that may hinder optimal mobility [18]. The mean fracture union time in the study group was recorded at 6.00 ± 0.46 weeks ($Z = 5.410$, $p < 0.001$), indicating a relatively accelerated healing process. This suggests that the technique employed may promote more efficient bone regeneration and remodeling. Similar conclusions have been reached in other investigations, which have associated certain surgical interventions with enhanced biological healing mechanisms, as reported by Klosterhoff et al [19]. Nonetheless, contrasting evidence exists. For instance, both Stumpfe et al. [20] and Xie et al. [21] have presented divergent data, showing that although micro plate fixation may offer rigid support, it might also result in delayed healing due to intraoperative complexity or technical demands. However, in the current study, complication rates remained relatively low, implying that micro plate fixation may offer a safer alternative with reduced risk of postoperative issues. This is supported by literature suggesting that this technique is generally associated with lower rates of infection and minimal requirement for secondary interventions [22]. Ultimately, the study's findings revealed that 75% of the patients experienced excellent clinical outcomes, further confirming the effectiveness of micro plate fixation in managing acute bony mallet injuries. Other studies have also reported enhanced functional recovery and higher patient satisfaction using micro plate methods for a range of hand injuries, including mallet fingers [23]. For example, Li et al. [24] highlighted that while micro plate fixation provides reliable structural support, this does not always correlate with superior patient satisfaction or functional scores due to possible complications or prolonged rehabilitation following more invasive surgical approaches. Further research with larger sample sizes and longer follow-up periods is recommended to confirm these results and refine treatment strategies for mallet finger fractures.

6. Conclusions

The use of micro plate fixation appears to be a highly effective option for the surgical management of acute bony mallet finger fractures, particularly in clinical scenario where preserving optimal functional outcomes is most importance. The technique offers several advantages, including the

potential for precise anatomical reduction, stable fixation, early mobilization and a favorable union time, all of which contribute to improved recovery and patient satisfaction. Despite the relatively higher complexity of the procedure and the observed complication rate, the majority of patients achieved excellent outcomes in terms of range of motion, grip strength, and overall function. Therefore, micro plate fixation represents a reliable and beneficial approach for treating such injuries, especially in cases that meet the radiographic and clinical criteria for operative intervention.

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