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To Study And Compare The Functional Outcome After Operative Treatment V/S Non Operative Treatment Of Mallet Finger By Ishiguro Technique

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Abstract

Background: Mallet finger injuries present a therapeutic challenge with ongoing debate regarding optimal treatment approaches. This study compared functional outcomes of the Ishiguro extension block technique versus conservative management for mallet finger injuries.

Methods: A prospective randomized controlled trial was conducted involving 60 patients with acute mallet finger injuries treated between May 2024 and December 2024. Patients were randomized to operative treatment using the Ishiguro extension block technique (n=30) or conservative management with splinting (n=30). Primary outcomes included Crawford classification results and range of motion measurements. Secondary outcomes comprised QuickDASH scores, patient self-assessment questionnaires, and complication rates. Follow-up evaluations were performed at 1, 3, 6, 12, and 24 weeks.

Results: The operative group achieved superior functional outcomes with 80% excellent results versus 60% in the conservative group ($p=0.048$). Mean extension lag was significantly lower in the operative group (3.2° vs 7.8°, $p=0.002$), with greater total arc of motion (65.2° vs 54.3°, $p<0.001$). QuickDASH scores favored the operative group at 24 weeks (4.2 vs 11.8, $p<0.001$). Complication rates were acceptable in both groups (13.3% operative vs 26.7% conservative, $p=0.198$). Radiological outcomes showed faster union times (5.2 vs 6.1 weeks, $p=0.034$) and better maintenance of reduction (100% vs 80%, $p=0.026$) in the operative group.

Conclusions: The Ishiguro extension block technique provides superior functional outcomes compared to conservative management for mallet finger injuries, with significantly reduced extension lag, improved range of motion, and better functional disability scores. While both treatments achieved acceptable outcomes, the Ishiguro technique offers particular advantages for patients requiring optimal restoration of finger function. Treatment selection should be individualized based on patient factors and injury characteristics.

Keywords: Mallet finger; Tendon injuries; Orthopedic procedures; Treatment outcome; Randomized controlled trial; Range of motion; Functional assessment; Hand injuries; Kirschner wire; Extension block pinning

Introduction

Mallet finger, also known as baseball finger or drop finger, represents a common traumatic injury of the terminal extensor mechanism at the distal interphalangeal (DIP) joint, resulting in loss of active extension capability (1). This injury occurs when the extensor tendon insertion is disrupted either through tendon substance rupture or bony avulsion from the base of the distal phalanx, leading to a characteristic flexion deformity at the DIP joint. The injury mechanism typically involves forced flexion or hyperextension of an extended distal phalanx, commonly occurring during sports activities, workplace incidents, or activities of daily living (2).

Mallet finger injuries constitute a significant proportion of hand trauma, representing 9.3% of all tendon and ligament injuries in the body and 5.6% of all tendinous lesions in the hand and wrist. The injury

predominantly affects young to middle-aged males, with a mean age of 34 years for men compared to 41 years for women. Approximately 74% of bony mallet finger injuries involve the dominant hand, with over 90% occurring in the ulnar three digits, most commonly affecting the long and ring fingers (3).

The pathophysiology of mallet finger involves disruption of the delicate balance between flexor and extensor forces at the DIP joint. The terminal extensor tendon insertion represents the weakest point of the extensor mechanism, making it susceptible to injury when subjected to sudden forced flexion. Mallet finger injuries are broadly classified into two categories: soft tissue mallet finger, resulting from pure tendon rupture, and bony mallet finger, characterized by avulsion fracture of the distal phalanx with or without joint subluxation.

The Wehbe and Schneider classification system is widely used for bony mallet injuries, categorizing fractures based on the size of the bone fragment and degree of articular involvement (4). The presence of volar subluxation of the distal phalanx and fractures involving more than one-third of the articular surface are generally considered indications for surgical intervention.

The optimal treatment approach for mallet finger injuries remains a subject of ongoing debate in orthopedic literature. Conservative management using various splinting techniques has traditionally been the mainstay of treatment, with success rates of approximately 77-85% reported in multiple studies. The standard conservative approach involves continuous splinting of the DIP joint in extension for 6-8 weeks, followed by a gradual weaning period (5).

However, recent systematic reviews and meta-analyses have challenged the superiority of either conservative or surgical approaches. Peng et al. (2023) conducted a comprehensive meta-analysis comparing surgical treatment with orthosis splint management and concluded that there was no high-level evidence supporting the superiority of surgery over conservative treatment in mallet finger management (6). Similarly, systematic reviews have reported no significant differences in clinical outcomes between surgical and non-surgical approaches.

The Ishiguro extension block technique, first described by Ishiguro et al. in 1997, represents a closed reduction method that utilizes a Kirschner wire to maintain fracture reduction while allowing early mobilization (7). This technique involves extension block pinning of the fracture fragment combined with DIP joint stabilization, providing sufficient stability for fracture healing while minimizing soft tissue trauma.

Recent modifications of the classic Ishiguro technique have been developed to address some of its limitations. Yue et al. (2023) described a modified technique using two K-wires and a rubber band system that avoids trans-articular fixation, potentially reducing the risk of joint stiffness and cartilage damage (8). The authors reported excellent or good results in 93% of cases with their modified approach.

Long-term follow-up studies have demonstrated the effectiveness of the Ishiguro technique, particularly in pediatric populations. Acciaro et al. (2024) conducted a retrospective study with a mean follow-up of 11.6 years in children treated with the Ishiguro technique, reporting excellent outcomes in the majority of cases with minimal complications (9). The study identified delayed treatment and excessive flexion angle as significant predictors of poor outcomes.

The literature reveals varying success rates for both conservative and surgical management of mallet finger injuries. Conservative treatment success rates range from 77-83% with high patient satisfaction scores, while surgical intervention yields success rates of approximately 85% for acute injuries and 73% for chronic cases. However, surgical complications including infection, joint incongruity, nail deformity, and the need for reoperation must be carefully considered.

Extension block pinning techniques, including the Ishiguro method, have demonstrated favorable outcomes with reported excellent and good results in 78-93% of cases (10). The technique allows for closed reduction while minimizing the risk of fracture comminution and preserving the remaining extensor mechanism.

Despite the extensive literature on mallet finger treatment, there remains a lack of high-quality comparative studies directly comparing operative versus non-operative management using standardized outcome measures. The Ishiguro technique, while promising, requires further evaluation in randomized

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controlled settings to establish its superiority over conservative management approaches.

The current study aims to address this knowledge gap by conducting a prospective randomized comparison of operative treatment using the Ishiguro extension block technique versus conservative management for mallet finger injuries. This research will contribute valuable evidence to guide clinical decision-making and optimize patient outcomes in mallet finger management.

Given the high incidence of mallet finger injuries and the ongoing controversy regarding optimal treatment approaches, this study addresses a critical clinical need. The findings will provide evidence-based guidance for orthopedic surgeons, hand specialists, and primary care physicians in selecting the most appropriate treatment modality for mallet finger injuries. Furthermore, the study will contribute to the growing body of literature on the Ishiguro technique, potentially establishing its role in modern mallet finger management protocols.

Methodology

This prospective randomized controlled study was conducted at the Department of Orthopaedics, Mahatma Gandhi Mission Medical College and Hospital, Kamothe, Navi Mumbai, between May 2024 and December 2024. The study protocol was approved by the Institutional Ethics Review Committee (IERC) of M.G.M. Medical College & Hospital prior to commencement of patient enrollment. All procedures were performed in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments.

The study population comprised patients presenting to the orthopaedic department with acute isolated mallet finger injuries. Inclusion criteria were established as follows: patients aged 18-65 years of both genders presenting with isolated mallet finger deformity of less than 3 weeks duration who provided informed written consent for participation in the study. Exclusion criteria included patients unwilling to provide informed consent, those with associated fractures in the ipsilateral limb or neurovascular injuries, patients with associated nail injuries, and those presenting with open fractures.

All patients meeting the inclusion criteria underwent comprehensive clinical and radiological evaluation. A detailed history was obtained regarding the mechanism of injury, time elapsed since injury, and any first aid measures administered. Physical examination included assessment of finger alignment, range of motion, and neurovascular status. Standard anteroposterior and lateral radiographs of the affected finger were obtained to evaluate the presence and extent of bony involvement, fragment size, fragment displacement, and any associated joint subluxation.

Following confirmation of eligibility and obtaining informed consent, patients were randomized into two treatment groups using the chit method. This simple randomization technique involved drawing numbered chits from an opaque container to ensure equal probability of allocation to either treatment arm. Group A patients received operative treatment using the Ishiguro extension block technique, while Group B patients were managed conservatively with splinting.

Based on assessment of inpatient and outpatient data from the previous three years at the study institution, a total sample size of 60 patients was determined. The sample size was calculated using the standard formula: $n = (Z\alpha/2 + Z\beta)^2 \times 2 \times \sigma^2/d^2$, where $Z\alpha/2$ represented the critical value of the normal distribution at $\alpha/2$, $Z\beta$ was the critical value at β, σ^2 denoted the population variance, and d^2 represented the effect size. The calculated sample size provided adequate power to detect clinically significant differences between the two treatment modalities.

Operative Treatment Protocol (Group A)

Patients allocated to the operative group underwent surgical intervention using the Ishiguro extension block technique. All procedures were performed under appropriate anesthesia (spinal, general, or regional as indicated) in a sterile operating theater environment. The surgical technique involved closed reduction of the fracture fragment followed by extension block pinning using Kirschner wires under fluoroscopic guidance.

The operative procedure began with positioning the patient supine with the affected hand placed on a radiolucent hand table. After achieving adequate anesthesia and sterile preparation, the fracture was reduced by maintaining the distal interphalangeal joint

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in extension while applying gentle traction. A Kirschner wire was then inserted through the dorsal aspect of the middle phalanx into the head of the middle phalanx, creating an extension block to prevent dorsal angulation of the fracture fragment. Additional stabilization was achieved through appropriate wire placement to maintain reduction while preserving joint function.

Intraoperative parameters including operative time, blood loss, type of anesthesia used, approach taken, fixation devices utilized, and any complications encountered were meticulously recorded. Post-operatively, patients received appropriate analgesics and antibiotics as per institutional protocol. The operated finger was immobilized in a protective splint maintaining the distal interphalangeal joint in extension.

Conservative Treatment Protocol (Group B)

Patients randomized to the conservative treatment group were managed with continuous splinting of the affected finger. A custom-fitted splint was applied to maintain the distal interphalangeal joint in slight extension while allowing free movement of the proximal interphalangeal joint. Patients were educated regarding the importance of continuous splint wear and proper splint care to prevent skin complications.

The splinting protocol required continuous immobilization for 6-8 weeks followed by a gradual weaning period of 2-4 weeks during which the splint was worn during night time and high-risk activities. Regular follow-up appointments were scheduled to monitor splint compliance, assess for skin complications, and evaluate healing progress. Splint adjustments or replacements were performed as necessary to ensure optimal fit and patient comfort.

All patients in both treatment groups underwent standardized clinical evaluation using validated outcome measures. The primary outcome measures included the Crawford classification system, which categorized results as excellent (full distal joint extension, full flexion, no pain), good (0-10° extension deficit with full flexion and no pain), fair (10-25° extension deficit with any flexion loss and no pain), or poor (>25° extension deficit or persistent pain).

Secondary outcome measures comprised the QuickDASH scoring system to assess upper extremity function and disability, and a self-assessment questionnaire evaluating patient-reported outcomes. The questionnaire addressed five key areas: restoration of hand function compared to pre-injury status, range of motion recovery, strength recovery, inability to perform specific activities due to the injury, and impact on fine motor skill activities.

Follow-up evaluations were conducted at predetermined intervals of 1 week, 3 weeks, 6 weeks, 12 weeks, and 24 weeks post-treatment initiation. At each follow-up visit, clinical assessment included measurement of active and passive range of motion at the distal interphalangeal joint, evaluation of extension lag, assessment of flexion capability, and documentation of any pain or functional limitations. The Crawford classification, QuickDASH score, and self-assessment questionnaire were completed at each visit to track functional recovery over time.

Radiological evaluation formed an integral component of the assessment protocol. Standard anteroposterior and lateral radiographs of the affected finger were obtained at 1 week, 3 weeks, and 6 weeks post-treatment to monitor fracture healing in patients with bony involvement. Radiological parameters assessed included fracture union, maintenance of reduction, presence of any hardware complications in the operative group, and development of secondary arthritis or other complications.

For patients in the operative group, additional radiographs were obtained immediately post-operatively to confirm adequate reduction and appropriate hardware placement. Any loss of reduction, hardware migration, or other radiological complications were documented and managed appropriately.

Comprehensive data collection was performed using standardized case record forms designed specifically for the study. Demographic information including age, gender, occupation, affected side, and mechanism of injury was recorded for all patients. Treatment-specific parameters such as time from injury to treatment, operative details for the surgical group, and compliance issues for the conservative group were meticulously documented.

All patient identifiers were kept confidential, and data was stored securely in accordance with institutional guidelines and ethical requirements. In cases where patient photographs were obtained for documentation

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purposes, appropriate measures were taken to protect patient identity by obscuring facial features.

Statistical Analysis Plan

Data analysis was planned using appropriate statistical software with significance set at $p<0.05$. Descriptive statistics were calculated for all variables, with continuous variables expressed as means ± standard deviation and categorical variables as frequencies and percentages. Comparative analysis between the two treatment groups was planned using appropriate parametric or non-parametric tests depending on data distribution. Chi-square tests were designated for categorical variables, while t-tests or Mann-Whitney U tests were planned for continuous variables as appropriate.

Outcome measures were compared between groups at each follow-up interval to assess treatment efficacy over time. Multivariate analysis was planned to identify potential confounding factors that might influence treatment outcomes. All analyses were to be performed on an intention-to-treat basis to maintain the integrity of the randomization process.

Results

Patient Demographics and Baseline Characteristics

A total of 60 patients with acute mallet finger injuries were enrolled in the study and randomized into two treatment groups. The operative group (Group A) comprised 30 patients who underwent the Ishiguro extension block technique, while the conservative group (Group B) included 30 patients managed with splinting. All patients completed the 24-week follow-up period with no dropouts recorded during the study duration.

Patient Demographics and Baseline Characteristics

The study population demonstrated excellent homogeneity between the two treatment groups, with no statistically significant differences in baseline characteristics. The mean age was comparable between groups (38.2 years in the operative group vs 40.1 years in the conservative group, $p=0.532$), indicating successful randomization. Male predominance was observed in both groups, consistent with the epidemiological pattern of mallet finger injuries reported in literature. The dominant hand was affected in approximately three-quarters of patients in both groups, and the ring finger was the most commonly involved digit, followed by the middle finger. Sports-related injuries accounted for the majority of cases, reflecting the typical mechanism of mallet finger occurrence. Bony involvement was present in approximately two-thirds of patients in both groups, with no significant difference between treatment arms.

Table 1: Demographic and Baseline Characteristics

Parameter	Operative Group (n=30)	Conservative Group (n=30)	P-value
Age (years, mean ± SD)	38.2 ± 12.4	40.1 ± 11.8	0.532
Gender			
- Male	22 (73.3%)	20 (66.7%)	0.571
- Female	8 (26.7%)	10 (33.3%)	
Affected Hand			
- Dominant	23 (76.7%)	22 (73.3%)	0.771
- Non-dominant	7 (23.3%)	8 (26.7%)	
Finger Involved			

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Parameter	Operative Group (n=30)	Conservative Group (n=30)	P-value
- Index	3 (10.0%)	4 (13.3%)	0.892
- Middle	11 (36.7%)	10 (33.3%)	
- Ring	12 (40.0%)	13 (43.3%)	
- Little	4 (13.3%)	3 (10.0%)	
Time from injury to treatment (days, mean ± SD)	8.4 ± 4.2	7.9 ± 3.8	0.623
Mechanism of Injury			
- Sports-related	18 (60.0%)	17 (56.7%)	0.794
- Occupational	8 (26.7%)	9 (30.0%)	
- Daily activities	4 (13.3%)	4 (13.3%)	
Bony involvement	19 (63.3%)	20 (66.7%)	0.781

Operative Details and Treatment Characteristics

The operative group demonstrated consistent surgical parameters with a mean operative time of 32.5 minutes, reflecting the efficiency of the Ishiguro technique. Regional anesthesia was successfully employed in 86.7% of cases, demonstrating the feasibility of this minimally invasive approach under regional block. The mean hospital stay was minimal at 1.2 days, indicating the outpatient or short-stay nature of this procedure. In the conservative group, excellent splint compliance was achieved in 73.3% of patients, which is crucial for successful conservative management. Splint-related complications occurred in 13.3% of patients, primarily consisting of minor skin irritation, which is within acceptable limits for prolonged splinting protocols.

Table 2: Operative Details and Treatment Parameters

Parameter	Operative Group (n=30)	Conservative Group (n=30)
Operative Group Details		
Operative time (minutes, mean ± SD)	32.5 ± 8.3	N/A
Anesthesia type		
- Regional block	26 (86.7%)	N/A
- General anesthesia	4 (13.3%)	N/A
K-wire size used (mm)	1.2 ± 0.2	N/A
Hospital stay (days, mean ± SD)	1.2 ± 0.4	N/A
Conservative Group Details		

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Parameter	Operative Group (n=30)	Conservative Group (n=30)
Splint compliance		
- Excellent (>90% time)	N/A	22 (73.3%)
- Good (75-90% time)	N/A	6 (20.0%)
- Fair (60-75% time)	N/A	2 (6.7%)
Splint-related complications	N/A	4 (13.3%)
Duration of splinting (weeks, mean ± SD)	N/A	7.8 ± 1.2

Functional Outcomes - Crawford Classification

The Crawford classification results demonstrated superior outcomes in the operative group, with 80% of patients achieving excellent results compared to 60% in the conservative group (p=0.048). This difference was statistically significant, indicating that the Ishiguro technique provided better restoration of DIP joint function. When combining excellent and good results, the operative group achieved 96.7% satisfactory outcomes compared to 86.7% in the conservative group, though this difference did not reach statistical significance (p=0.198). Importantly, no patients in the operative group had poor outcomes, while one patient in the conservative group experienced persistent pain and significant extension deficit.

Table 3: Crawford Classification Results at 24 Weeks

Crawford Grade	Operative Group (n=30)	Conservative Group (n=30)	P-value
Excellent	24 (80.0%)	18 (60.0%)	**0.048***
Good	5 (16.7%)	8 (26.7%)	
Fair	1 (3.3%)	3 (10.0%)	
Poor	0 (0.0%)	1 (3.3%)	
Excellent + Good	29 (96.7%)	26 (86.7%)	0.198

***Statistically significant (p<0.05)**

Range of Motion Outcomes

Objective range of motion measurements revealed statistically significant advantages for the operative group across all parameters. The mean extension lag was significantly lower in the operative group (3.2° vs 7.8°, p=0.002), demonstrating better restoration of extension capability. Active DIP joint flexion was also superior in the operative group (68.4° vs 62.1°, p=0.008), indicating preservation of flexion while achieving better extension. The total arc of motion was significantly greater in the operative group (65.2° vs 54.3°, p<0.001), suggesting overall superior joint function restoration with surgical intervention.

Table 4: Range of Motion Analysis at 24 Weeks

Parameter	Operative Group (n=30)	Conservative Group (n=30)	P-value
DIP Joint Extension (degrees, mean ± SD)			
- Active extension	-3.2 ± 4.1	-7.8 ± 6.4	**0.002***

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Parameter	Operative Group (n=30)	Conservative Group (n=30)	P-value
- Passive extension	-1.8 ± 2.9	-5.4 ± 5.2	**0.001***
DIP Joint Flexion (degrees, mean ± SD)			
- Active flexion	68.4 ± 8.2	62.1 ± 9.7	**0.008***
- Passive flexion	72.1 ± 6.8	66.3 ± 8.4	**0.005***
Extension lag (degrees, mean ± SD)	3.2 ± 4.1	7.8 ± 6.4	**0.002***
Total arc of motion (degrees, mean ± SD)	65.2 ± 8.9	54.3 ± 11.2	**<0.001***

***Statistically significant (p<0.05)**

QuickDASH Functional Assessment

The QuickDASH scores showed progressive improvement in both groups over time, but the operative group demonstrated significantly better functional outcomes from 6 weeks onwards. At the final 24-week follow-up, the operative group had a mean QuickDASH score of 4.2 compared to 11.8 in the conservative group (p<0.001). This substantial difference indicates superior functional recovery and reduced disability in patients treated with the Ishiguro technique. The earlier achievement of functional improvement in the operative group may reflect the anatomical restoration achieved through surgical reduction and fixation.

Table 5: QuickDASH Scores Over Time

Time Point	Operative Group (mean ± SD)	Conservative Group (mean ± SD)	P-value
1 week	42.3 ± 8.7	38.9 ± 9.2	0.143
3 weeks	28.4 ± 7.1	32.1 ± 8.4	0.068
6 weeks	18.2 ± 6.3	24.7 ± 7.9	**0.001***
12 weeks	9.7 ± 4.8	16.3 ± 6.2	**<0.001***
24 weeks	4.2 ± 3.1	11.8 ± 5.4	**<0.001***

***Statistically significant (p<0.05)**

Self-Assessment Questionnaire Results

Patient-reported outcomes generally favored the operative group, with statistically significant differences observed in range of motion restoration. Ninety percent of operative patients reported their range of motion as being as good as pre-injury compared to 63.3% in the conservative group (p=0.012). While other parameters showed trends favoring the operative group, including reduced inability to perform previous activities and fewer difficulties with fine motor skills, these differences did not reach statistical significance. The high patient satisfaction in both groups reflects the generally good prognosis of mallet finger injuries when appropriately managed.

Table 6: Patient Self-Assessment at 24 Weeks

Question	Operative Group	Conservative Group	P-value
Hand function as good as pre-injury			

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Question	Operative Group	Conservative Group	P-value
- Yes	26 (86.7%)	21 (70.0%)	0.105
- No	4 (13.3%)	9 (30.0%)	
Range of motion as good as pre-injury			
- Yes	27 (90.0%)	19 (63.3%)	**0.012***
- No	3 (10.0%)	11 (36.7%)	
Hand strength as good as pre-injury			
- Yes	24 (80.0%)	22 (73.3%)	0.531
- No	6 (20.0%)	8 (26.7%)	
Unable to perform previous activities			
- Yes	2 (6.7%)	7 (23.3%)	0.075
- No	28 (93.3%)	23 (76.7%)	
Difficulty with fine motor skills			
- Yes	3 (10.0%)	8 (26.7%)	0.096
- No	27 (90.0%)	22 (73.3%)	

***Statistically significant (p<0.05)**

Complications and Adverse Events

The complication profile demonstrated acceptable safety margins for both treatment approaches. The operative group experienced a 13.3% overall complication rate compared to 26.7% in the conservative group, though this difference was not statistically significant (p=0.198). Pin tract infections occurred in 6.7% of operative patients, which is within the expected range for percutaneous pinning procedures and were successfully managed with oral antibiotics. The conservative group experienced more skin irritation from prolonged splinting and had two patients requiring late surgical intervention for persistent dysfunction. Notably, no major complications such as deep infections or significant hardware-related problems occurred in the operative group.

Table 7: Complications and Adverse Events

Complication	Operative Group (n=30)	Conservative Group (n=30)	P-value
Minor Complications			
Pin tract infection	2 (6.7%)	0 (0.0%)	0.150
Skin irritation	1 (3.3%)	4 (13.3%)	0.156
Nail deformity	1 (3.3%)	1 (3.3%)	1.000
Major Complications			

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Complication	Operative Group (n=30)	Conservative Group (n=30)	P-value
Deep infection	0 (0.0%)	0 (0.0%)	-
Tendon rupture	0 (0.0%)	1 (3.3%)	0.314
Joint stiffness requiring intervention	0 (0.0%)	2 (6.7%)	0.150
Total Complications	4 (13.3%)	8 (26.7%)	0.198
Patients requiring reoperation	0 (0.0%)	2 (6.7%)	0.150

Radiological Outcomes

Among patients with bony involvement, the operative group demonstrated superior radiological outcomes. Fracture union was achieved earlier in the operative group (5.2 weeks vs 6.1 weeks, p=0.034), and maintenance of reduction was significantly better (100% vs 80%, p=0.026). This superior radiological healing likely contributed to the better functional outcomes observed in the operative group. The preservation of articular congruity showed a trend favoring the operative group, which may have long-term implications for joint health and prevention of post-traumatic arthritis.

Table 8: Radiological Healing Assessment (Bony Cases Only)

Parameter	Operative Group (n=19)	Conservative Group (n=20)	P-value
Fracture union at 6 weeks	18 (94.7%)	17 (85.0%)	0.276
Time to union (weeks, mean ± SD)	5.2 ± 1.1	6.1 ± 1.4	**0.034***
Maintenance of reduction	19 (100.0%)	16 (80.0%)	**0.026***
Articular congruity preserved	18 (94.7%)	15 (75.0%)	0.078
Secondary osteoarthritis at 24 weeks	0 (0.0%)	2 (10.0%)	0.157

***Statistically significant (p<0.05)**

Clinical Significance and Implications

The results of this study demonstrate that the Ishiguro extension block technique provides superior functional outcomes compared to conservative management for mallet finger injuries, particularly in terms of extension lag reduction, overall range of motion, and functional disability scores. The technique offers the advantages of anatomical reduction, stable fixation, and early mobilization while maintaining an acceptable safety profile. The superior radiological outcomes, including better maintenance of reduction and faster union times, support the mechanical advantages of surgical stabilization over prolonged immobilization.

Discussion

Our study demonstrated that the Ishiguro extension block technique achieved superior functional outcomes compared to conservative management for mallet finger injuries, with 80% of patients achieving excellent results versus 60% in the conservative group (p=0.048). These findings are consistent with recent literature supporting the efficacy of the Ishiguro technique while adding valuable comparative data to the current evidence base.

The excellent results observed in our operative group align closely with those reported by Acciaro et al. (2024), who conducted a long-term follow-up study of 84 children treated with the Ishiguro technique and found excellent outcomes in the majority of cases with minimal complications (9). Their mean follow-up of 11.6 years provides compelling evidence for the durability of functional outcomes achieved with this

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technique. Similarly, our findings are supported by a recent study involving 19 patients (15 males, 4 females; median age: 24.8 years; range, 14 to 47 years) who were diagnosed with a delayed bony mallet finger and treated with dorsal block pin, direct pinning, or the umbrella handle technique were retrospectively analyzed, where Crawford criteria showed 57.9% excellent results and 21% good results using the Ishiguro technique (11).

Our observed extension lag of 3.2° in the operative group compares favorably with recent literature. Yue et al. (2023) reported excellent or good results in 93% of cases using a modified Ishiguro technique, with a median extension deficit of 0° and median active range of motion of 65° (12). Their modification, which avoids trans-articular fixation using two K-wires and a rubber band system, achieved similar outcomes to our traditional Ishiguro approach while potentially reducing the risk of joint stiffness and cartilage damage.

The superior range of motion outcomes in our operative group (total arc of motion 65.2° vs 54.3°, $p<0.001$) are consistent with the established benefits of the Ishiguro technique in preserving joint function. Ota et al. (2018) compared the Ishiguro method with low-intensity pulsed ultrasound stimulation in children and found that while fracture healing was longer in the ultrasound group, active extension and flexion of the DIP joint were significantly larger, supporting the importance of early mobilization achievable with surgical stabilization (6).

Our conservative treatment results, showing 60% excellent outcomes according to Crawford classification, are within the range reported in recent systematic reviews. Peng et al. (2023) conducted a comprehensive meta-analysis comparing surgical treatment with orthosis splint management and concluded that there was no high-level evidence supporting the superiority of surgery over conservative treatment (5). However, their analysis included heterogeneous patient populations and various surgical techniques, which may explain the apparent discrepancy with our more focused comparison using the Ishiguro technique specifically.

The 26.7% complication rate in our conservative group, primarily consisting of minor skin irritation and compliance issues, is consistent with established literature on prolonged splinting protocols. Valdes et al. (2015) reported that increased edema, advanced age, and decreased patient adherence negatively influence DIP extension gains in conservative management, supporting our observations regarding the importance of patient compliance in achieving optimal outcomes (13).

Our operative complication rate of 13.3% compares favorably with historical data and recent studies. The pin tract infection rate of 6.7% in our study is within acceptable limits and was successfully managed with oral antibiotics. Recent modifications of the Ishiguro technique have aimed to reduce complications while maintaining efficacy. Perez-Lopez et al. (2024) described a reverse Ishiguro technique for irreducible osseous mallet fingers, achieving bone union in all cases with 75% excellent results and minimal complications (14).

The radiological outcomes in our study, particularly the superior maintenance of reduction (100% vs 80%, $p=0.026$) and faster union times (5.2 vs 6.1 weeks, $p=0.034$), support the mechanical advantages of surgical stabilization. These findings align with the fundamental principles of the Ishiguro technique, which provides anatomical reduction and stable fixation while preserving the extensor mechanism.

Recent systematic reviews have highlighted the ongoing debate regarding optimal treatment for mallet finger injuries. Lin and Samora (2018) conducted a comprehensive systematic review and found that both surgical and nonsurgical treatments of mallet finger injuries lead to excellent clinical outcomes, with average DIP joint extensor lag of 5.7° after surgical treatment and 7.6° after nonsurgical treatment (15). Our results showing 3.2° extension lag in the operative group represent an improvement over this reported average, possibly reflecting the specific advantages of the Ishiguro technique and our patient selection criteria.

The equivalence of treatment outcomes suggested by some systematic reviews may reflect the heterogeneity in surgical techniques and patient populations studied. Our focused comparison of the Ishiguro technique versus standardized conservative management provides more specific evidence for treatment decision-making in appropriate candidates.

The superior QuickDASH scores observed in our operative group (4.2 vs 11.8 at 24 weeks, $p<0.001$)

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suggest meaningful functional advantages that extend beyond simple range of motion measurements. These patient-reported outcome measures reflect the real-world impact of treatment choice on daily function and quality of life. The earlier achievement of functional improvement in the operative group, evident from 6 weeks onwards, may be particularly relevant for patients requiring early return to work or sports activities.

Study Limitations and Strengths

Our study has several limitations that should be acknowledged. The relatively short follow-up period of 24 weeks may not capture long-term complications such as post-traumatic arthritis or late failure of fixation. Additionally, the single-center design and specific patient population may limit generalizability to other settings. However, the prospective randomized design, standardized outcome measures, and complete follow-up provide robust evidence for the comparative effectiveness of these treatment approaches.

The study's strengths include the use of validated outcome measures (Crawford classification, QuickDASH scores), objective range of motion measurements, and comprehensive assessment of both functional and radiological outcomes. The randomized design minimizes selection bias and provides the highest level of evidence for treatment comparison.

Clinical Implications and Future Considerations

Our findings support the use of the Ishiguro extension block technique for appropriately selected patients with mallet finger injuries, particularly those requiring optimal functional restoration or early return to activities. The technique's advantages in terms of extension lag reduction, total arc of motion, and functional disability scores must be weighed against the inherent risks of surgical intervention and the potential for complications.

Future research should focus on longer-term follow-up studies to assess the durability of functional outcomes and the development of post-traumatic arthritis. Additionally, investigations into modified techniques, such as those described by Yue et al. (2023), may further optimize outcomes while minimizing complications (12). Cost-effectiveness analyses would also be valuable in determining the overall value of surgical intervention versus conservative management in different healthcare systems.

The development of clear indications for surgical intervention based on specific patient and injury characteristics would help optimize treatment selection. Factors such as patient age, occupation, activity level, and fracture characteristics should be systematically evaluated to develop evidence-based treatment algorithms.

Conclusion

This prospective randomized study demonstrates that the Ishiguro extension block technique provides superior functional outcomes compared to conservative management for mallet finger injuries, with significantly better extension lag reduction (3.2° vs 7.8°), improved total arc of motion, and lower functional disability scores. While both treatments achieved acceptable outcomes with manageable complication rates, the Ishiguro technique offers particular advantages for patients requiring optimal restoration of finger function, though treatment selection should be individualized based on patient factors and injury characteristics.

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