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Delta Frame Versus Blocking Wire in Management of Mallet Finger. Which has Better Surgical Outcome? A Systematic Review and Meta-Analysis

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Abstract:- Purpose: The aim of this study is to compare the clinical outcomes of delta wire technique and extension block pinning in terms of distal interphalangeal joint active flexion, extension lag, union time, the visual analogue scale and Crawford criteria. Trying to find out the best surgical intervention to treat mallet fractures.

Methods: In order to prepare this systematic review and meta-analysis, we adhered to the PRISMA statement's requirements. Using pertinent keywords, a computerized literature search was done in Cochrane Central, Web of Science, and PubMed. Utilizing Review Manager Version 5.4.1 for Windows, data was retrieved and synthesized from the records after they had been checked for admissible studies. Case studies, clinical trials, and randomized control trials about mallet fracture in individuals older than 18 were all included. We took open fractures out, and the injury happened more than four weeks after the initial injury.

Results: This study provides evidence that extension block technique has better outcome regarding active distal interphalangeal flexion than the delta wire, but there is no difference between the two techniques regarding degree of extension lag, union time, and visual analog scale and Crawford criteria.

Conclusion: Further high quality randomize control studies between the two techniques is needed to find out the best surgical way to treat mallet fracture.

Keywords:- *Mallet finger, Delta frame, Delta wiring, Block wire, blocking wire, pinning.*

I. INTRODUCTION

Mallet fracture is intraarticular fracture involving the distal phalanx. This can happen from heavy object strikes the tip of the finger or thumb. Also it can happen from axial loading towards the tip of phalanx with passive DIP (distal interphalangeal joint) hyperflexion [1], [2]. If a mallet finger not treated promptly, it might results in function impairment of the involved digit [3]. The ultimate goal of treatment is to restore active distal interphalangeal range of movement, prevention of early osteoarthritis and pain relief. [4], [5]. Treatment of mallet fractures varies from conservative and surgical intervention. Conservative treatment leads to excellent results if the fracture fragment less than one-third of distal phalanx. Although several surgical techniques have been prescribed in literature, such as extension block pinning and delta wire [5] [6] [7], the best technique is still controversial. Extension block method first described by Ishiguro [1], it is technically simple and has good outcome. However, it can lead to stiffness due to the trans-articular wire [8] [9]. Delta technique described by Kim et al avoids trans-articular wire and achieved good results [4]. This review aims at synthesizing evidence from published studies about the best surgical way to treat mallet fracture by comparing the two most common techniques, extension block pinning and delta wire technique.

II. METHODS

PRISMA guidelines were followed for this review and meta-analysis preparation.

A. Inclusion and exclusion criteria

Studies fulfilling the following criteria were included in this study: (1) randomized controlled trials, case series that prescribed delta wire technique and extension block pinning. (2) Studies of mallet finger injuries in adults. (3) Studies reporting the following outcomes (Union rate, DIP stiffness, recovery time, Crawford's criteria and DIP extension lag).We excluded studies in languages other than English language, thesis, conference abstracts, studies with data not reliable for extraction and analysis. Also the studies whose patients has open fracture were excluded.

B. Search strategy

We conducted a computer-based literature search using the relevant keywords. PubMed, web of science and Cochrane were used for the search. We used the following search strategy: (mallet finger) OR (delta frame teqni*) OR (extension block wire*). Two steps conducted by two authors screened the titles and abstracts of the retrieved citations. Eligibility screening was performed in two steps. The first step was titles and abstracts for eligibility, the second step, full-text articles of eligible citations were retrieved and screened for meta-analysis eligibility.

C. Quality assessment

Cochrane Collaboration's tool for assessing risk of bias was used to identify the quality of the included studies. The Cochrane Collaboration's risk of bias assessment guidelines includes the following: sequence generation (selection bias), allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective outcome reporting (reporting bias) and other potential sources of bias. The authors' assessment is classified as 'Low risk', 'High risk' or 'Unclear risk' of bias.

D. Data synthesis

In a meta-analysis module using RevMan version 5.4.1 for Windows, scores for the union rate, DIP stiffness, recovery time, Crawford's criterion, and DIP extension lag were pooled as mean difference (MD) and standardized mean difference (SMD).

E. Assessment of heterogeneity

Visual assessment of the forest plots and I-square and Chi-Square tests were used to determine heterogeneity. The random effects model was applied when there was significant heterogeneity. The fixed effect model was applied in the other cases.

III. RESULTS

A. Search results

Six hundred and fifty one distinct articles were identified in our search. Only 27 titles were qualified for full-text screening after the abstract screening. In the final, 123 participants from five studies were determined to be eligible for the final analysis (see PRISMA flow diagram; "Fig. 1"). "Table 1" summarizes the key findings of the studies that were included, while "Table 2" lists the demographic baseline characteristics.

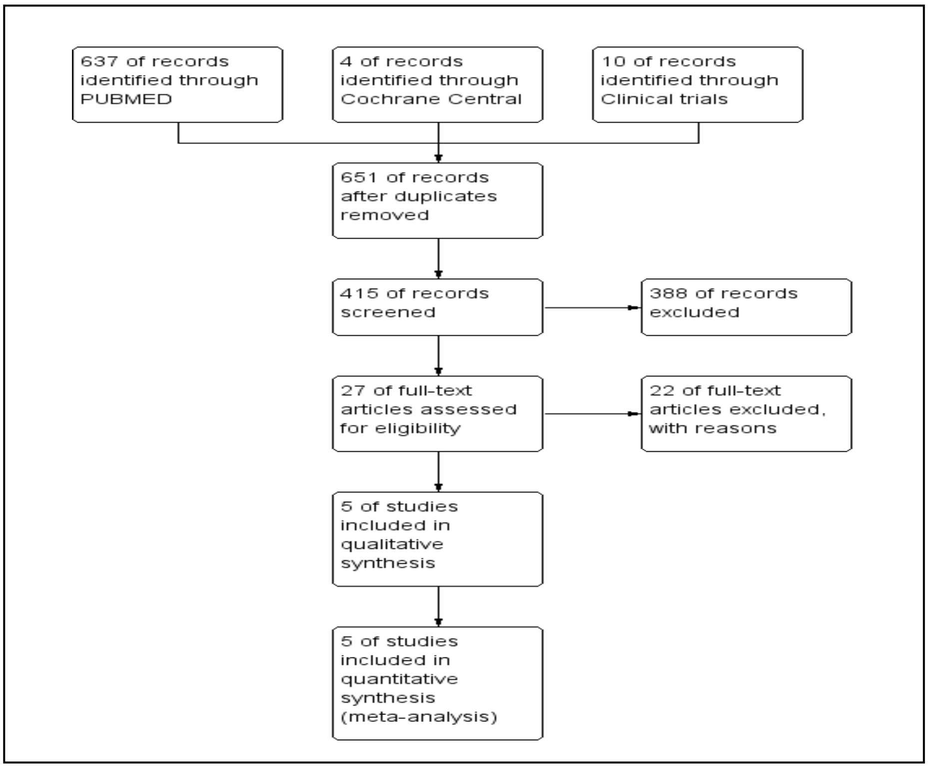

Fig. 1: PRISMA flow diagram

Study	Design	Intervention	Population	Result
Chee 2020 [10]	RCT	Delta wire versus extension block	Mallet fracture involving one-third or more of distal phalanx	Extension block has better clinical outcome
Garg 2020 [12]	RCT	Delta wire	Mallet fracture involving one-third of distal phalanx	Delta wire is a useful method to treat mallet fracture
Kim 2016 [4]	Cross sectional	Delta wire	Mallet fracture involving one-third of distal phalanx	Delta wire has low risk of iatrogenic Chondral damage
Ozgozen 2021[11]	Cross sectional	Delta wire versus extension block	Mallet fracture involving one-third of distal phalanx	No difference between the two groups
Yoon 2017 [13]	RCT	Extension block wire	Mallet fracture involving one-third of distal phalanx	Extension block has good functional outcome

Table 1: Summary of the included studies

B. Quality of included studies

According to the Cochrane risk of bias assessment criteria, the included studies were of moderate to high quality. "Fig. 2" displays a summary of the quality assessment domains used in the included research. Also "Fig. 3".

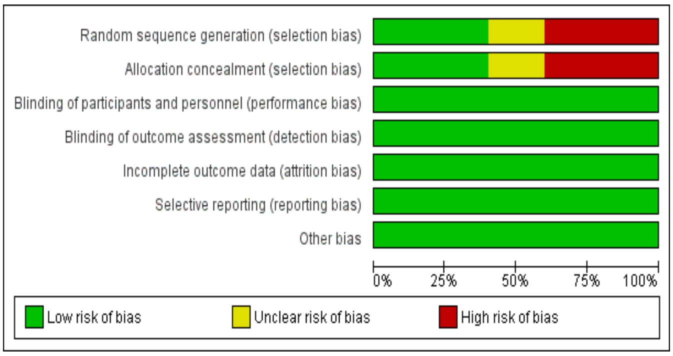

Fig. 2: Risk of bias graph: Percentages representing the review authors' assessments of each risk of bias item across all included studies

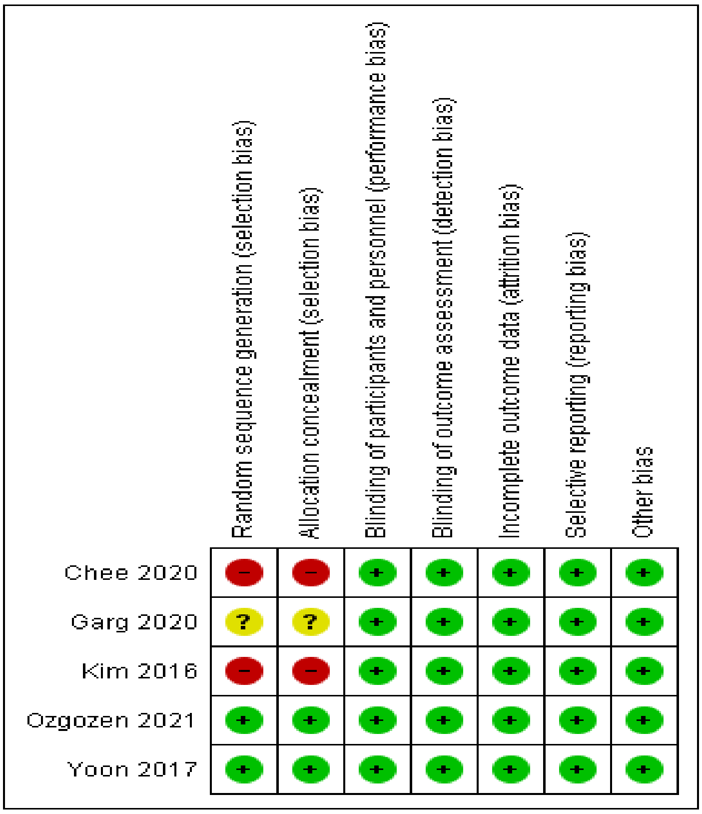

Fig. 3: Review authors' assessments of each risk of bias item for each included study to summarize the risk of bias

C. Outcome analysis

a) Active DIP flexion

The overall standardized mean difference between the delta wire and the extension block pinning favored the extension block pinning (standardized main difference 0.98, 95% CI [0.21 to 1.75], P=0.01).

Pooled studies were not homogenous (Chi-square P=0.03, I-square=70%). "*Fig. 4*"

b) DIP extension lag

The overall standardized mean difference between the delta wire and the extension block pinning did not favor either of the two groups (standardized main difference 0.29, 95% CI [-070 to 1.28], P=0.56).

Pooled studies were not homogenous (Chi-square P=0.002, I-square=83%). "*Fig. 5*"

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c) Visual analogue scale for pain
The overall standardized mean difference between the delta wire and the extension block pinning did not favor either of the two groups (main difference -0.12, 95% CI [-0.55 to 0.30], P=0.56).

Pooled studies were homogenous (Chi-square P=0.53, I-square=0%). *"Fig. 6"*

d) Union time
The overall standardized mean difference between the delta wire and the extension block pinning did not favor either of the two groups (main difference 0.09, 95% CI [-0.31 to 0.49], P=0.67).

Pooled studies were homogenous (Chi-square P=0.17, I-square=46%). *"Fig. 7"*

e) Crawford criteria
The overall standardized mean difference between the delta wire and the extension block pinning did not favor either of the two groups (standardized main difference 0.14, 95% CI [-1.13 to 1.42], P=0.83).

Pooled studies were not homogenous (Chi-square P=0.0001, I-square=90%). *"Fig. 8"*

IV. DISCUSSION

This study provides evidence that extension block technique has better outcome regarding active DIP flexion than the delta wire, but there is no difference between the two techniques regarding degree of extension lag, union time, VAS score and Crawford criteria.

This results are against the previous agreement that the delta wire technique has better outcome regarding DIP flexion as the patient starts active range of movement of DIP joint immediately after operation. Also the fact that extension block technique has trans-articular wire which may cause a degree of articular cartilage damage and limits DIP flexion.

V. CONCLUSION

Further high quality randomize control studies between the two techniques is needed to find out the best surgical way to treat mallet fracture.

	Delta Wire			Extension Block				Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Chee 2020	67.9	2.67	7	56.8	6.43	11	22.6%	1.98 [0.78, 3.18]
Ozgozen 2021	79.1	6.7	23	71.2	8.2	25	37.9%	1.03 [0.43, 1.64]
Yoon2017 & Kim2016	76	7.5	26	73	8.75	26	39.5%	0.36 [-0.19, 0.91]
Total (95% CI)			**56**			**62**	**100.0%**	**0.98 [0.21, 1.75]**

Heterogeneity: Tau² = 0.31; Chi² = 6.74, df = 2 (P = 0.03); I² = 70%
Test for overall effect: Z = 2.49 (P = 0.01)

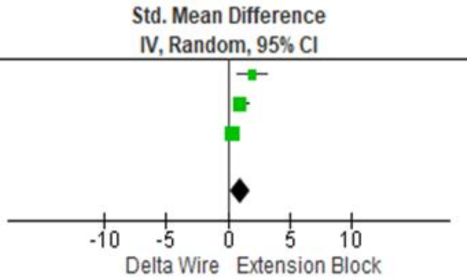

Fig. 4: Forest Plot of standardized mean difference (SMD) of DIP active flexion with 95% confidence interval

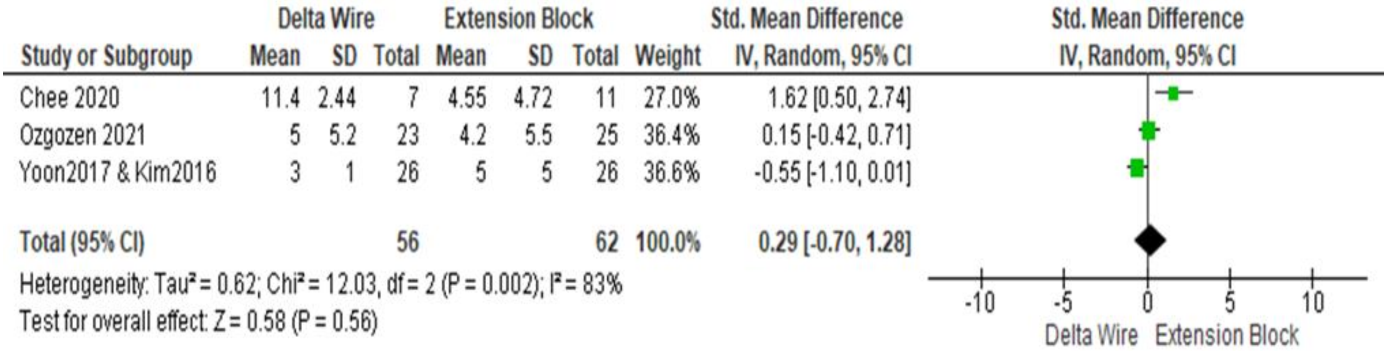

Fig. 5: Forest Plot of standardized mean difference (SMD) of distal interphalangeal joint extension lag with 95% confidence interval

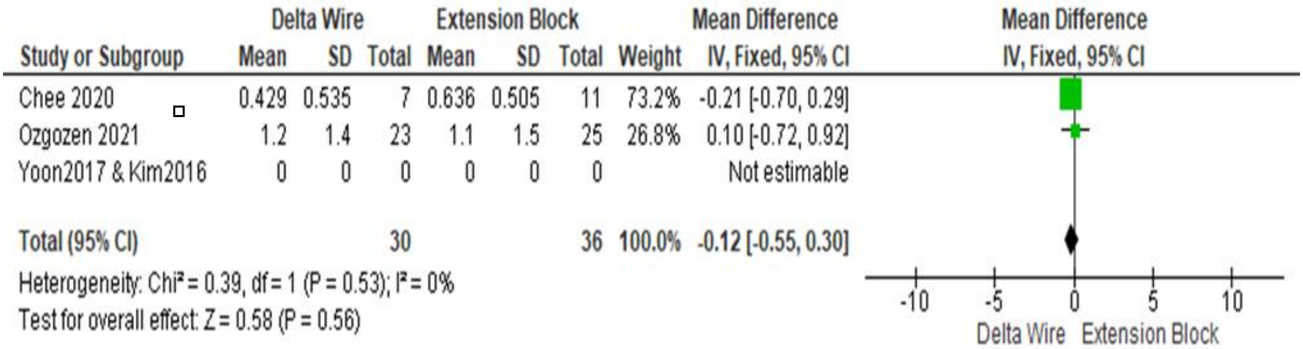

Fig. 6: Forest Plot of mean difference (MD) of VAS with 95% confidence interval

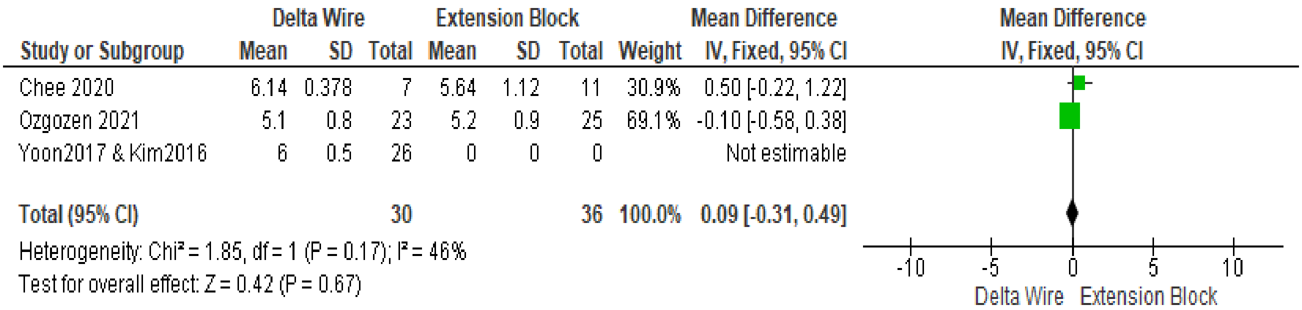

Fig. 7: Forest Plot of mean difference (MD) of union time with 95% confidence interval

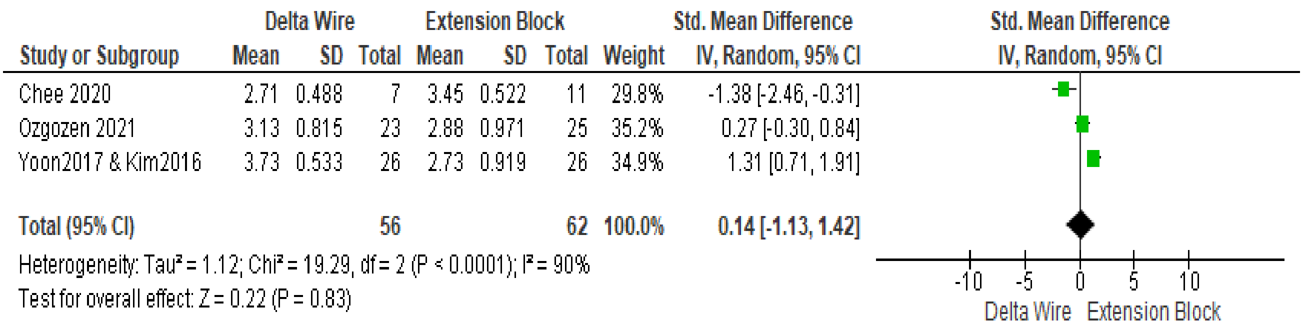

Fig. 8: Forest Plot of standardized mean difference (SMD) of Crawford criteria with 95% confidence interval

Study ID	Group	Sample size	Age mean (SD)	Gender Male %	Crawford criteria Mean (SD)	DIP active flexion (SD)	DIP extension lag	Union time (weeks)
Chee2020 [10]	Delta Wire	7	29.3 (6.5)	4 57.1%	2.71 (0.488)	67.9 (2.67)	11.4 (2.44)	6.14 (0.378)
	Extension block	11	32.5 (13.9)	6 54.54%	3.45 (0.522)	56.8 (6.43)	4.55 (4.72)	5.64 (1.12)
Garg2020 [12]	Delta Wire	5	26.8 (4.82)	4 80%	3.2 (0.447)	73 (2.74)	5.4 (3.21)	6.4 (0.548)
	Extension block							
Ozgozen2021 [11]	Delta Wire	23	32 (12.5)	15 65.2%	3.13 (0.815)	79.1 (6.7)	5 (5.2)	5.1 (0.8)
	Extension block	25	34 (10.4)	16 64%	2.88 (0.971)	71.2 (8.2)	4.2 (5.5)	5.2 (0.9)
Yoon2017 [13]	Delta Wire							
	Extension block	26	37 (12.25)	17 35.38%	2.73 (0.919)	73 (8.75)	5 (5)	
Kim2016 [4]	Delta Wire	26	34.5 (7)	16 61.53%	3.73 (0.533)	76 (7.5)	3	6

Table 2: Baseline characters of included studies

DIP (Distal interphalangeal joint) SD (Standard deviation)

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