Egypt, J. Plast. Reconstr. Surg., Vol. 46, No. 2, April: 179-187, 2022

Modalities for the Management of Proximal Interphalangeal Fractures: A Systematic Review and Meta-Analysis

MIRA SAMEH WILLIAM, M.B.B.Ch.; KARIM KHALIL ELLAMIE, M.D.;
AHMED M. GAD, M.D. and ADEL HUSSEIN, M.D.

The Department of Plastic, Burn and Maxillofacial Surgery, Faculty of Medicine, Ain Shams University

ABSTRACT

Background: Given the possible long-term consequences of the implicated finger and whole hand, treating proximal interphalangeal joint (PIPJ) fracture-dislocations is tough. The purpose of this review was to compare different modalities for management of proximal interphalangeal fractures.

Material and Methods: For all studies on PIPJ fracture-dislocations, a literature review was conducted using PubMed, SCOPUS, Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science database. Outcomes of interest included VAS analogue, function score (QDASH), Range of Motion (ROM), grip strength, and the incidence of postoperative complications. Open Reduction Internal Fixation (ORIF), percutaneous fixation, Dynamic Distraction External Fixation (DDEF), Extension-Block Pinning (EBP), and Hemihamate Arthroplasty (HA) were the surgical methods used to divide the articles into five groups.

Results: The search yielded 688 distinct results. After that, we kept 54 records that were possibly suitable for full-text screening. Finally, 21 studies were included (with a total of 242 patients). This study, The best overall effect for ROM was 83.4° in percutaneous fixation 83.4° for Extension Block Pinning, 78.4° in Hemihamate arthroplasty, also 78.4° for Dynamic External Fixation and ORIF with mini screw was 77.6°. In the current study Grip strength had overall effect (81.4%, 78.3% and 73.4%) for EBP, Hemihamate arthroplasty and ORIF respectively.

Regarding Q DASH its overall effect was 11.9 following Hemi hamate arthroplasty and 5.3 following EBP. There was no substantial heterogeneity in the pooled trials.

Conclusion: In a review of post-operative outcomes, no surgical strategy to PIPJ fracture-dislocation therapy consistently generated consistently better average post-operative function data. Treatment for PIPJ necessitates deliberation and is ultimately determined by the kind of fracture, the region of impacted joint space, and the magnitude of the fracture.

Key Words: *Digits – Anatomy – Finger – Fracture/Dislocation – Diagnosis – Hand therapy – Specialty – Surgery.*

Disclosure: No conflict of interest.

INTRODUCTION

Interphalangeal fractures are one of the most frequent kind of injuries in the human body. They account for 10% of all fractures and 1.5% of all emergency room visits. The phalanges are the most often injured parts of the hand (46 percent phalangeal, 36 percent metacarpal). The most frequent injuries are to the distal phalanx and border digits. Males are afflicted more than females. The little finger is the most often damaged digit **[1]**.

Falls, traffic accidents, and, more frequently, sports, particularly football and cricket, are all causative factors. Around 18 percent of all phalangeal fractures include a joint, mostly the proximal interphalangeal joint, and 8 percent involve comminution. The most prevalent concerns are stiffness and deformity, which are connected to a high risk of morbidity **[2]**.

The goal of proximal interphalangeal fracture management is to maintain gliding motion of the extensor and flexor tendons while the fractures heal in an appropriate alignment. Stable fracture may be treated without surgery, whereas unstable injuries need surgical intervention **[3]**. Surgical stabilization may result in additional tissue damage leading to adhesion, soft tissue damage and a restriction in range of motion of the surrounding joints. Furthermore, tendon gliding may be hampered by internal fixation devices. Conservative therapies like splints and braces, on the other hand, may not be capable of maintaining the lowered position. This may lead to a misalignment or a delayed union. Any prolonged immobility may cause joint stiffness, necessitating long-term physical therapy **[4]**. Despite the widespread use and feasibility of many of these techniques, there is a paucity of evidence in the literature that one method is better to another. As a result, to assess different treatment options for proximal interphalangeal fractures, we conducted the present systematic review and meta-analysis.

Aim of the work:

This review aimed to compare different modalities for management of proximal interphalangeal fractures in terms of union, function score (QDASH), Range of motion, grip strength and VAS analogue.

MATERIAL AND METHODS

Study selection:

This systematic review and meta-analysis were conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) statement. Authors, Editors, and Reviewers of Interventional and Observational Studies may use PRISMA and MOOSE as reporting checklists. Reviewers must submit their conclusions in accordance with each of the elements mentioned in those checklists, according to the International Committee of Medical Journal Association (ICJME). We looked at randomized controlled trials, non-randomized comparative trials, and observational studies, single-arm trials, prospective cohort studies, and retrospective studies in patients with proximal interphalangeal fractures with different modalities (surgical and non-surgical) for management of these fractures. The outcomes measures are VAS analogue, function score (QDASH), Range of motion, grip strength, and the incidence of post-operative complications. We did not include abstracts from conferences, theses, other systematic reviews, technical notes, papers, remarks, and research that were not written in English.

Eligibility criteria:

To find relevant publications, an electronic search was performed in the following bibliographic databases from the beginning to April 2020: Medline through PubMed, SCOPUS, Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science.

The following queries were used in various combinations: “PIP fracture dislocation” OR “proximal interphalangeal fracture”. After removing duplicates, the authors separately examined the titles and abstracts of the records that had been obtained. Studies that seem to be potentially suitable will be kept for full-text screening. Any disagreements were handled by consensus at any point. English was the language of the selected studies that written between 2000 and 2020. Additionally, References / Bibliography of the selected articles was examined to evaluate potential for further research and possible inclusion in the analysis for any other citations.

Data extraction:

MS Excel was used to create a uniform extraction form. Each of the included studies will provide the following data, which will be extracted separately by the authors:

1- Research characteristics.

2- Baseline characteristics of participants.

3- Areas of risk of bias.

4- Endpoint outcomes were range of motion, function score (QDASH), pain, grip strength, and VAS analogue.

Dealing with missing data: Standard error or the 95 percent confidence interval were used to determine the missing standard deviation (SD) of mean change from baseline confidence interval, according to Altman (CI).

Statistical analysis: The inverse variance technique was used to pool Continuous outcomes are expressed as a mean difference (MD) or a standardized mean difference (SMD) and the Mantel-Haenszel method was used to pool dichotomous outcomes as relative risk (RR). Under the premise of substantial clinical and methodological variability, the random-effects approach was employed. We used Review Manager (RevMan) 5.3 for Windows to conduct all statistical analyses.

RESULTS

I- *Search results:*

In the present study, we searched Medline via PubMed, SCOPUS, Web of Science, Cochrane Central Register of Controlled Trials (CENTRAL), and Science Direct from their inception till April 2020. The search retrieved 688 unique records. We then retained 54 potentially eligible records for full-texts screening. Finally, 21 studies (No. of patients=242 patients) were included (Figure).

Range of motion:

Three studies reported the range of motion following ORIF with mini screw. The overall effect showed that the range of motion following ORIF with mini-screw was 77.6 (95% CI 69.2-86.1). There was no substantial heterogeneity in the pooled studies. (p=0.21, I^2=36%); (Fig. 2).

Overall, three studies reported the range of motion following percutaneous fixation.

The entire result indicated that the range of motion was 83.4 following percutaneous fixation. (95 percent CI 79.5-87.2).

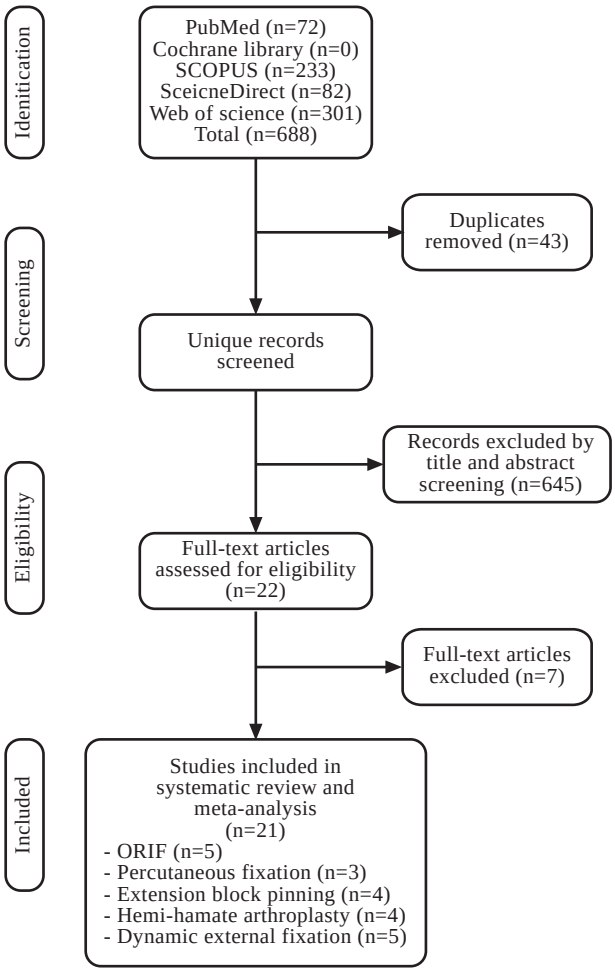

Fig. (1): PRISMA flow-chart.

There was no substantial heterogeneity in the pooled trials. (p=0.54; I^2=0%; Fig. 3).

Overall, three studies reported the range of motion following EBP. The overall effect showed that the range of motion following EBP was 83.4 (95% CI 79.5-87.2). There was no substantial heterogeneity in the pooled studies (p=0.54; Fig. 4).

Three studies reported the range of motion following Hemihamate arthroplasty. The overall effect showed that the range of motion following Hemihamate arthroplasty was 78.4 (95% CI 65.6-91.1). The pooled studies showed significant heterogeneity (p=0.09, I^2=57%; Fig. 5).

Three studies reported the range of motion following Dynamic distraction external fixator. The overall effect showed that the range of motion following Dynamic distraction external fixator was 78.4 (95% CI 65.6-91.1). The pooled studies showed significant heterogeneity (p=0.09, I^2=57%; Fig. 6).

Grip strength:

Two studies reported the grip strength following ORIF with mini screw. The overall effect showed that the grip strength following ORIF with mini-screw was 73.4% (95% CI 64.8-81.9%). The pooled studies showed no significant heterogeneity (p=0.59, I^2=0%; Fig. 7).

Two studies reported the grip strength following EBP. The overall effect showed that the grip strength following EBP was 81.4% (95% CI 75.7-87.2%). The pooled studies showed no significant heterogeneity (p=0.54; Fig. 8).

Three studies reported the grip strength following Hemihamate arthroplasty. The overall effect showed that the grip strength following Hemihamate arthroplasty was 78.3% (95% CI 65.5-91.1%). Significant heterogeneity was seen in the pooled studies (p=0.09, I^2=57%; Fig. 9).

Quick DASH:

Two studies reported the Quick DASH following EBP. The overall effect estimates showed that Quick DASH following EBP was 5.3 (95% CI 4.6-5.9). The pooled studies showed significant heterogeneity (p=0.059; I^2=72%; Fig. 10).

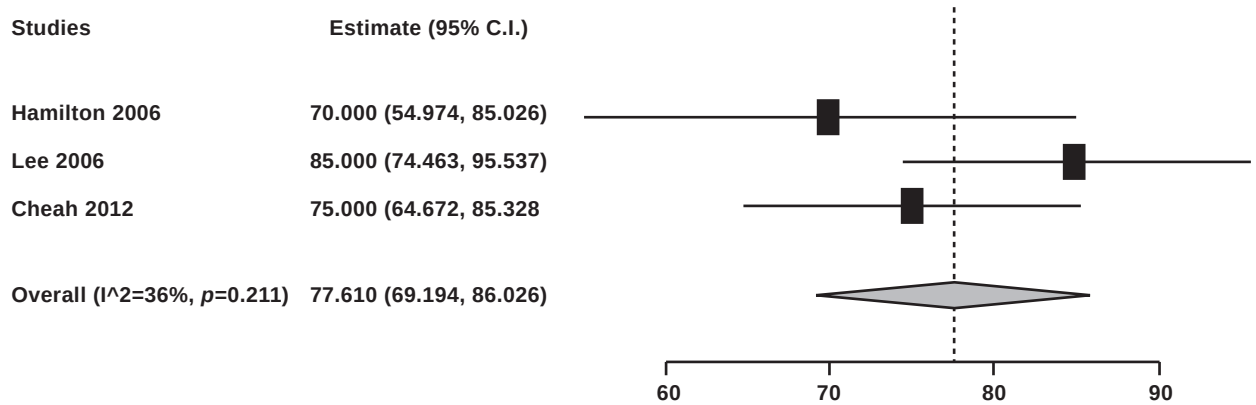

Fig. (2): Forest Plot of rates of range of motion following ORIF with mini screw.

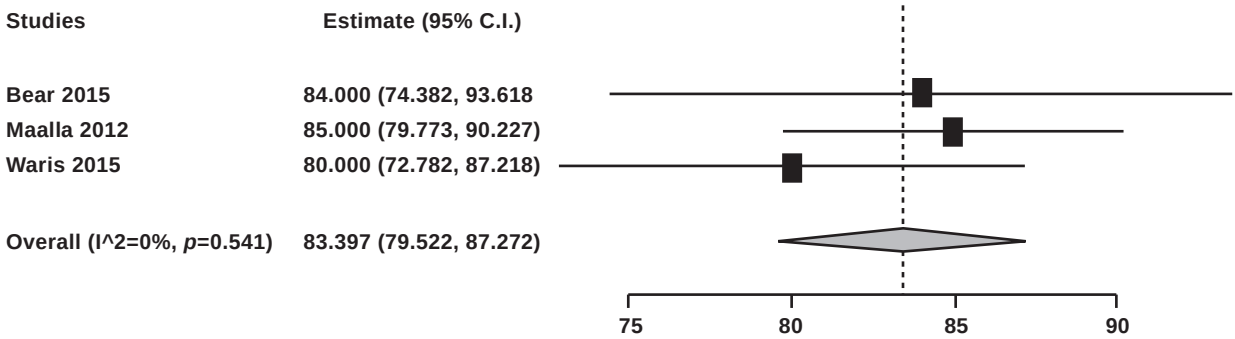

Fig. (3): Forest Plot of rates of range of motion following percutaneous fixation.

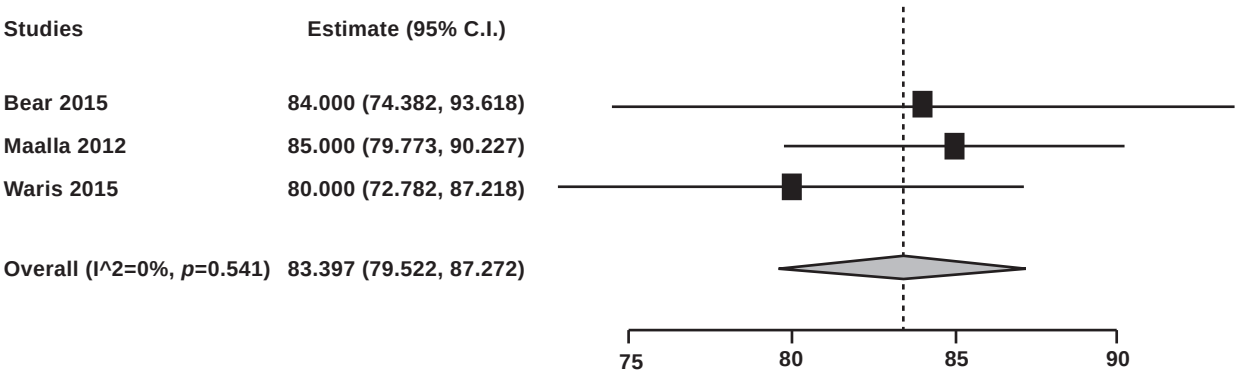

Fig. (4): Forest Plot of rates of range of motion following EBP.

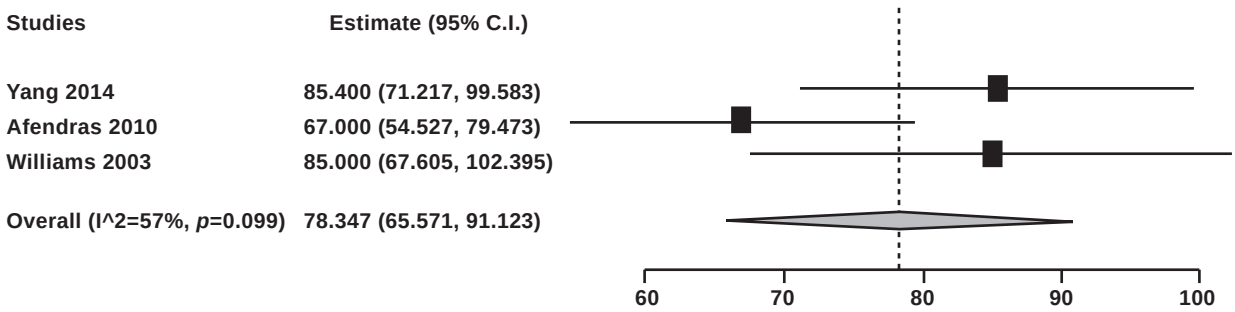

Fig. (5): Forest Plot of rates of range of motion following Hemihamate arthroplasty.

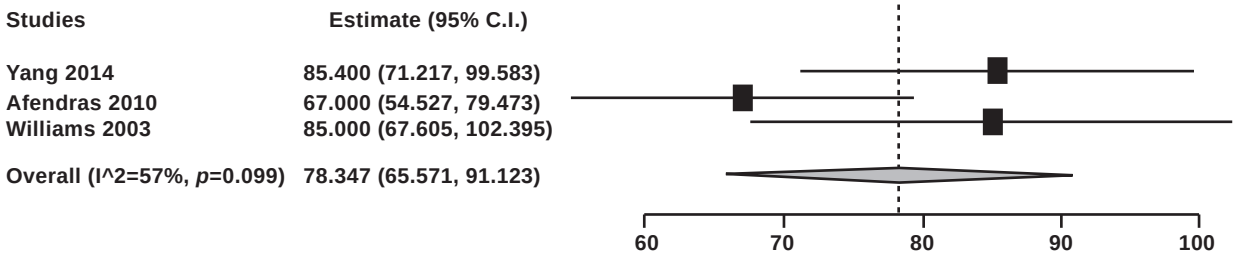

Fig. (6): Forest Plot of rates of range of motion following Dynamic distraction external fixator.

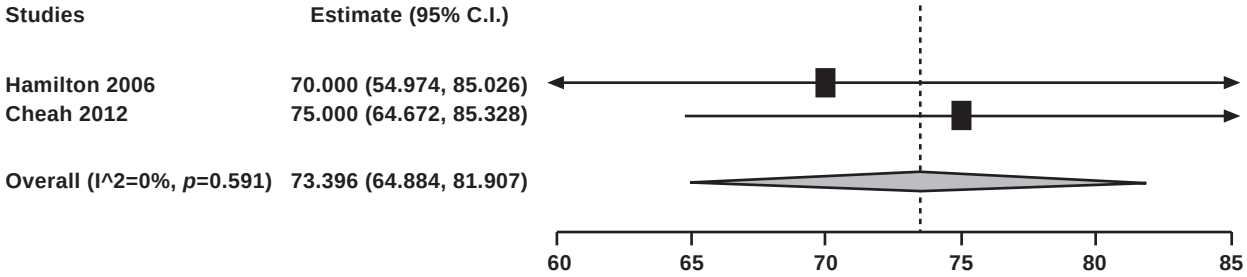

Fig. (7): Forest Plot of rates of grip strength following ORIF with mini screw.

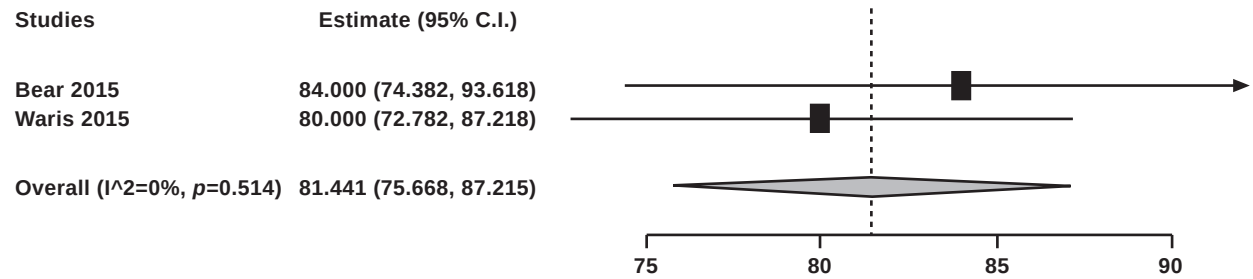

Fig. (8): Forest Plot of rates of grip strength following EBP.

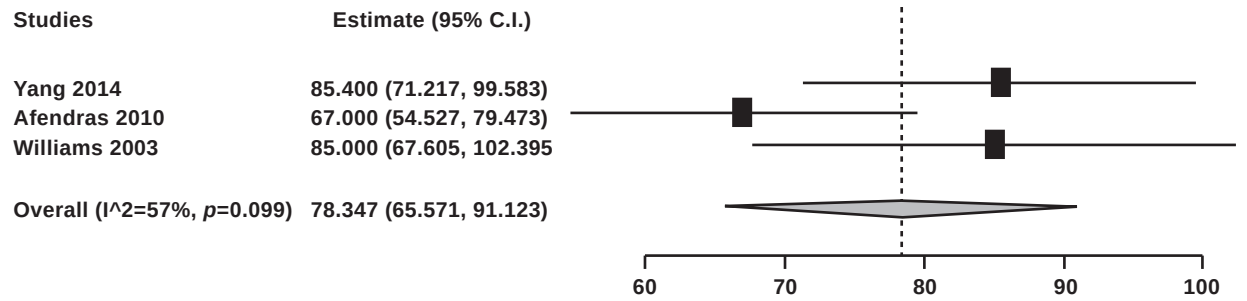

Fig. (9): Forest Plot of rates of grip strength following Hemihamate arthroplasty.

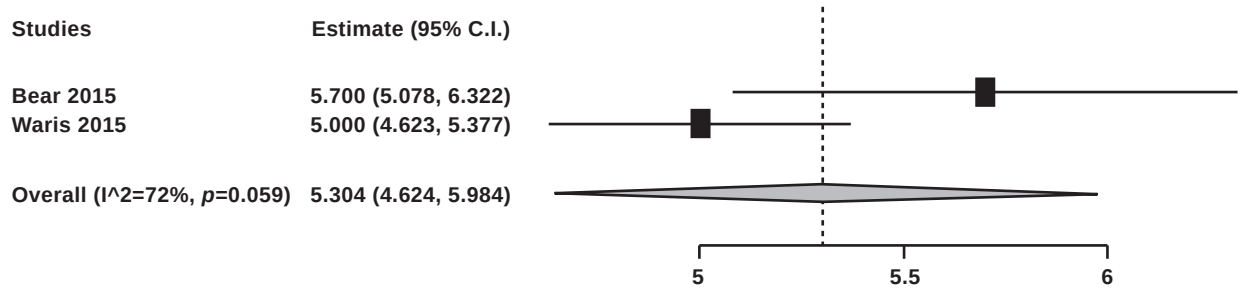

Fig. (10): Forest Plot of rates of Quick DASH following EBP.

Two studies reported the Quick DASH following Hemihamate arthroplasty. The overall effect estimates showed that Quick DASH following Hemihamate arthroplasty was 11.9 (95% CI 0-25.1). The pooled studies showed significant heterogeneity (p=0.001; I^2=100%; Fig. 11).

VAS score:

The overall effect estimates showed that the VAS score following Hemihamate arthroplasty was 1.4 (95% CI: 1.1-1.6). The pooled studies showed significant heterogeneity (p<0.001, I^2=95%; Fig. 12).

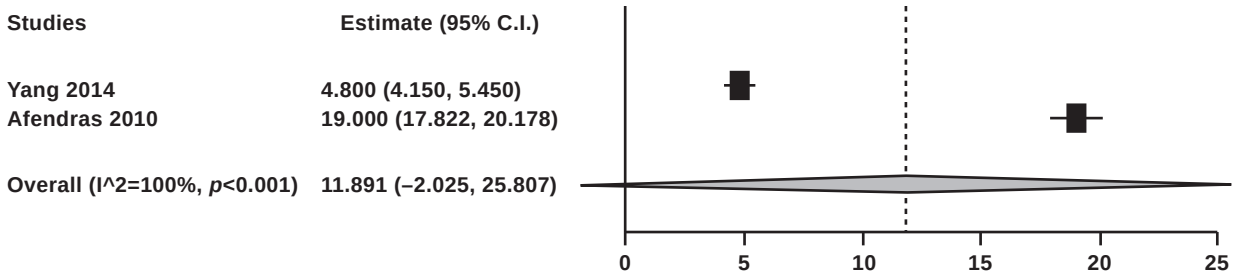

Fig. (11): Forest Plot of rates of Quick DASH following Hemihamate arthroplasty.

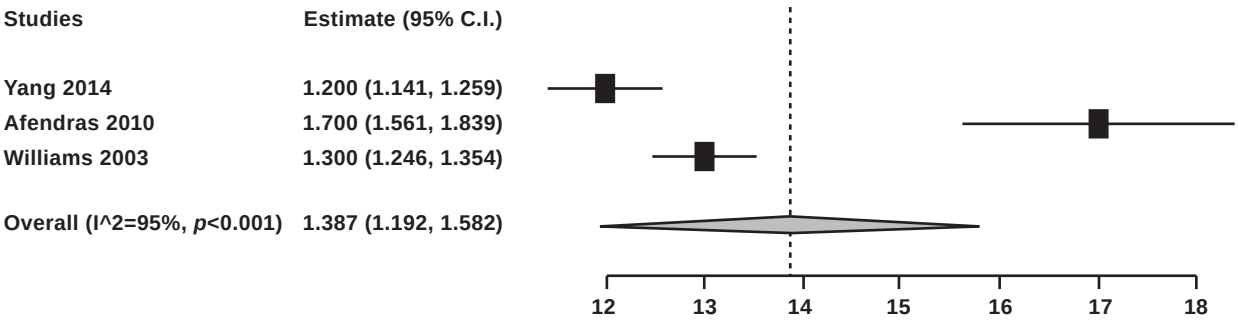

Fig. (12): Forest Plot of rates of VAS score following Hemihamate arthroplasty.

Table (1): Baseline characteristics of the included studies.

Technique	Author	No. of Hands	No. of Male	No. of Females	Avg. Age	Type of injuries
ORIF	Lee	9	8	1	31	Sport injuries, Slip down
	Cheah	13	11	2	33	Sport injuries, Motor vehicle accidents
	Hamilton	9	7	2	35	N/A
	Lee	12	8	4	30	Sport injuries, industrial accidents
	Grant	14	13	1	30	Sport injuries, industrial accidents
Percutaneous Fixation	Vitale	6	3	3	32	Sport injuries, Motor vehicle injuries
	Ikeda	15	10	5	25.5	Sport injuries, Motor vehicle injuries
	Newington	11	9	1	N/A	N/A
EBP	Bear	12	7	5	30	Sport injuries, Motor vehicle injuries
	Maalla	36	32	4	37	Sport injuries, Motor vehicle injuries
	Waris	39	24	15	44	N/A
	Viegas	3	3	0	N/A	N/A
Hemihamate arthroplasty	Yang	11	8	3	30	HA technique is safe and reliable
	Afendras	4	4	0	25	HA technique is safe and reliable
	Williams	14	14	N/A	35	HA technique is safe and reliable
	Lindenblatt	4	4	0	41	HA technique is safe and reliable
DDEF	Finsen	18	12	6	54	Sport injuries, Motor vehicle injuries
	Ruland	34	27	7	30	Sport injuries, Motor vehicle injuries
	Macfarlane	28	19	9	33	Sport injuries, Motor vehicle injuries
	Wang	N/A	N/A	N/A	N/A	N/A
	Finsen	18	12	6	54	Sport injuries, Motor vehicle injuries

Open Reduction Internal Fixation (ORIF).
Extension Block Pinning (EBP).
Hemi hamate Arthroplasty (HA).
Dynamic Distraction External Fixation (DDEF)

Table (2): Outcome Measures of the included studies assessed ORIF.

Technique	Author	Avg. time to surgery (Days)	Avg. follow-up time (months)	PIPJ ROM	Grip Strength	Quick DASH	Post-operative subluxation	Post-operative dislocation	Plate and screw removal
ORIF	Lee	N/A	9	93.2	N/A	N/A	0	0	0
	Cheah	7	25	75	85%	4 (1)	0	0	4
	Hamilton	17	42	70	70%	N/A	1	0	0
	Lee	9.2	8	85	N/A	N/A	0	0	0
	Grant	21	39	94	N/A	N/A	2	1	0
Percutaneous fixation	Vitale	4	18	93	N/A	8	0	0	0
	Ikeda	5.1	14.2	84.9	N/A	N/A	N/A	N/A	N/A
	Newington	N/A	192	85	N/A	N/A	N/A	N/A	N/A
EBP	Bear	7.5	35	AROM 84	99.7%	5.7	0	1	0
	Maalla	N/A	31	PROM 93	NA	NA	0	0	0
	Waris	9	62	85	93%	5	12	N/A	
	Viegas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0
Hemihamate arthroplasty	Yang	0.2	38.1	85.4	94.5%	4.8	0	0	0
	Afendras	0.8	60	67	91%	19	0	0	0
	Williams	1.5	16	85	80%	NA	2	0	N/A
	Lindenblatt	2.5	24	N/A	N/A	N/A	0	0	2
DDEF	Finsen	4	49	72%	97%	2	0	0	0
	Ruland	NA	16	88%	NA	NA	0	0	0
	Macfarlane	7	22	85%	NA	20.3	2	0	N/A
	Wang	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Finsen	4	49	72%	97%	2	0	0	0

Open Reduction Internal Fixation (ORIF).
Extension Block Pinning (EBP).
Hemihamte Arthroplasty (HA).
Dynamic Distraction External Fixation (DDEF).
Active Range of Motion (AROM).
Passive Range of Motion (PROM).
Proximal Interphalangeal Joint (PIPJ).
Range of Motion (ROM)

DISCUSSION

Dislocations of the PIPJ may cause severe digit range of motion (ROM) limitations and, as a consequence, occupational impairment. In addition, untreated PIPJ fracture-dislocations may cause persistent joint instability, discomfort, osteoarthritis, and intra-articular deformity. We sought to evaluate various methods for treating proximal Inter phalangeal joint fractures in terms of function score (QDASH), pain, range of motion, and post-operative complications in this systematic study.

The current study discussed five main types of different modalities for management of proximal Inter phalangeal joint fractures; Open reduction internal fixation (ORIF), Percutaneous fixation, Extension Block Pinning EBP, Hemi-Hamate Arthroplasty and Dynamic External Fixation.

From their beginning until June 2021, researchers searched Medline through PubMed, SCOPUS, Web of Science, Cochrane Central Register of Controlled Trials (CENTRAL), and Science Direct. The search yielded 688 distinct results. After that, we kept 54 records that were possibly eligible for full-text screening. Finally, 21 studies were included (with a total of 242 participants).

ORIF three studies reported the range of motion following ORIF with mini screw. The overall effect showed that the range of motion following ORIF with mini-screw was 77.6° (95% CI 69.2-86.1).

Our findings, in comparison with 5 meta-analysis study in numerous studies, to describe the post-operative results of multiple treatment options for PIPJ fracture-dislocations, they had reported fourteen studies assessed ORIF (n=6; 146 hands), and the post-operative weighted average ranges was 84.7°.

In line also with Breahna et al. (2020) meta-analysis The mean ROM at the PIP joint Fixation similar in both groups (82°) **[17]**, while in Percutaneous Fixation the range of motion after percutaneous fixation was reported in three investigations. The overall effect showed that the range of motion following percutaneous fixation was 83.4 (95% CI 79.5-87.2). In the same line, Demino et al., found that the average range of motion following CRPP was 87.6 **[5]**.

Lahav et al., presented a procedure for treating volar lip fractures of the middle phalanx without accompanying dislocation, as well as affected intra-articular fractures of the middle phalanx, with better results utilizing dorsally inserted, percutaneously inserted K-wires **[13]**. Although Extension Block Pinning three studies described the range of motion after EBP. The total effect presented that the range of motion next EBP was 83.4 (95% CI 79.5-87.2).

In agreement with, Demino et al., as they stated four studies evaluated extension block pinning studies (n=4; 85 hands), and the post-operative weighted average ranges was 83.6° **[5]**. Waris and Alanen reported that he average grip strength on one side was three kilograms less than on the other, while no standard deviation was reported **[14]**.

Two studies in our meta-analysis reported the Quick DASH following EBP. The overall effect estimates presented that Quick DASH next EBP was 5.3 (95% CI 4.6-5.9).

Demino et al., described that the Quick DASH next EBP extended from 4.6 to 5.9 **[5]**. Waris and Alanen found average DASH score was **[4,14]**, and dynamic distraction external fixator (DDEF) is a viable treatment option for an unstable PIPJ fracture-dislocation. The DDEE device, however, cannot be completely realized due to loose joints surrounding soft tissue and firm fixation of joints following joint reduction. Thus, it is critical to understand how to efficiently provide joint stability and facilitate joint movement in advance **[12]**.

Demino et al., had reported thirty studies assessed DDEF (389 hands), and the post-operative weighted average ranges was 81.7° **[5]**.

Suzuki et al., and De Smet et al., both reported good outcomes using a DDEF that Suzuki et al., first described for comminuted intra-articular fractures of the PIPJ. The Suzuki device, on the other hand, is prone to cause inflammation around the pin sites due to friction at the bone-pin contact **[15,16]**.

Conclusion:

Through a literature review of post-operative outcomes, no surgical strategy to PIPJ fracture-dislocation treatment consistently generated consistently better average post-operative function data. Treatment for PIPJ necessitates deliberation and is ultimately determined by the kind of fracture, the region of the afflicted joint space, and the extent of the fracture.

Limitation:

The absence of standardized outcome measures resulted in not just reporting diversity, but also in the presentation of reported data. Furthermore, in other investigations, the fracture-dislocations subtype was not described.

REFERENCES

1- Kee C. and Massey P.: Phalanx Fracture, Stat Pearls Publishing, 2019.

2- Meier R.: Fractures of the phalanx. Pract. Proced. Orthop. Trauma Surg., p. 109-14, 2015. doi: 10.1017/cbo 9780511545726.015.

3- Lögters T.T., Lee H.H., Gehrmann S., Windolf J. and Kaufmann R.A.: Proximal Phalanx Fracture Management. Hand, 13: 376-83, 2018. doi: 10.1177/1558944717735947.

4- Jehan S., Chandraprakasam T. and Thambiraj S.: Management of proximal phalangeal fractures of the hand using finger nail traction and a digital splint: A prospective study of 43 cases. Clin. Orthop. Surg., 4: 156-62, 2012. doi: 10.4055/cios.2012.4.2.156.

5- Demino C., Yates M. and Fowler, JR.: Surgical management of proximal interphalangeal joint fracture-dislocations: A review of outcomes. Hand, 1558944 719873152, 2019.

6- Hamilton S.C., Stern P.J., Fassler P.R., et al.: Mini-screw fixation for the treatment of proximal interphalangeal joint dorsal fracture-dislocations. J. Hand Surg. Am., 8 (31): 1349-54, 2006.

7- Cheah, A.E., Tan, D.M., Chong, A.K., et al.: Volar plating for unstable proximal interphalangeal joint dorsal fracture-dislocations. J. Hand Surg. Am., 1 (37): 28-33, 2012.

8- Grant I., Berger A. and Tham S.: Internal fixation of unstable fracture dislocations of the proximal interphalangeal joint. Journal of Hand Surgery, 5 (30): 492-498, 2005.

9- Newington D., Davis T. and Barton N.: The treatment of dorsal fracture-dislocation of the proximal interphalangeal joint by closed reduction and Kirschner wire fixation: A 16-year follow-up. Journal of Hand Surgery, 6 (26): 537-540, 2001.

10- Vitale M.A., White N.J. and Strauch R.J.: A percutaneous technique to treat unstable dorsal fracture-dislocations of the proximal interphalangeal joint. The Journal of Hand Surgery, 9 (36): 1453-1459, 2011.

11- Maalla R., Youssef M., Ben Jdidia G., et al.: Extensionblock pinning for fracture-dislocation of the proximal interphalangeal joint. Orthopaedics & Traumatology: Surgery & Research, 5 (98): 559-563, 2012.

12- Wang H-Z., Zhao J-Y. and Zhang Z-S.: A novel dynamic distraction external fixator for proximal interphalangeal joint fracture dislocation. Journal of International Medical Research, 4 (47): 1628-1635, 2019.

13- Lahav A., Teplitz, G.A. and Mccormack Jr., R.R.: Percutaneous reduction and Kirschner-wire fixation of impacted intra-articular fractures and volar lip fractures of the proximal interphalangeal joint. American journal of orthopedics (Belle Mead, NJ), 2 (34): 62-65, 2005.

14- Waris E. and Alanen V.: Percutaneous, Intramedullary Fracture Reduction and Extension Block Pinning for Dorsal Proximal Interphalangeal Fracture-Dislocations. The Journal of Hand Surgery, 12 (35): 2046-2052, 2010.

15- Suzuki Y., Matsunaga T., Sato S. and Yokoi T.: The pins and rubbers traction system for treatment of comminuted intraarticular fractures and fracture-dislocations in the hand. The Journal of Hand Surgery: British & European, Volume 1 (19): 98-107, 1994.

16- De Smet L. and Boone P.: Treatment of fracture-dislocation of the proximal interphalangeal joint using the Suzuki external fixator. J. Orthop. Trauma, 9 (16): 668-71, 2002.

17- Breahna A., Mishra A., Arrowsmith J. and Lindau T.: The management of acute fracture dislocations of proximal interphalangeal joints: A systematic review. J. Plast. Surg. Hand Surg., 54: 323-7, 2020. doi: 10.1080/2000656X.2020.1788041.