

Protected Early Mobilization Using Buddy Taping Versus Splint Immobilization for Fifth Metacarpal Neck Fractures: A Meta-Analysis



Alfonso Pio Calimag, MD,¹ John Hubert Pua, MD¹

ABSTRACT

Metacarpal fractures are one of the more common fractures of the hand, with the fifth metacarpal neck fractures, commonly referred to as boxer's fractures, comprising around 20% of all hand fractures. Currently, a variety of surgical treatment methods may be used for management, such as wire or plate fixations. Although these methods provide stable reduction, they are limited by higher costs and their invasive nature. Therefore, boxer's fractures have traditionally been treated conservatively with cast or splint immobilization, with these methods showing good functional outcomes. Recently, however, there have been studies showing similar results with the use of protected early mobilization with the use of soft wraps and buddy taping.

This study aims to compare the patient-reported functional outcomes of treating undisplaced fifth metacarpal neck fractures with protected early mobilization using buddy taping versus cast/splint immobilization with the use of the Shortened Disability of the Arm, Shoulder and Hand Score (quickDASH). This study will be conducted with a comprehensive

literature search from PubMed, Cochrane Library, Embase, Google Scholar and ScienceDirect from inception to October 2022. All randomized control trials comparing protected early mobilization with buddy taping and cast/splint immobilization of the fifth metacarpal neck fractures will be included.

BACKGROUND

Epidemiology

Fractures of the fifth metacarpal neck, or boxer's fractures are one of the most common fractures of the hand accounting for about 20% of all hand fractures and 5% of fractures of the upper extremity.[3-5,7] Males are more commonly affected than females with a male-to-female ratio of 6:1. These fractures mostly occur in the working-age population, with 70% of these fractures occurring during the second to fifth decade of life, meaning that they may have profound socioeconomic consequences secondary to lost time off work.

Pathoanatomy

The most common mechanism of injury to the metacarpals remains to be trauma, with the boxer's fracture being caused by longitudinal compression force applied on the fifth knuckle when the hand is closed in a fist, as if throwing a punch.[3-5,7] Fortunately, metacarpal fractures are inherently stable due to the attachments of intrinsic muscles of the hand.

✉ Alfonso Pio Calimag, MD
calimagpio@gmail.com

¹ Department of Orthopaedics, University of Santo Tomas Hospital, Manila, Philippines

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Fifth metacarpal neck fractures usually present with volar angulations with the fracture apex directed dorsally. Angulations of 30 degrees have been proposed to be the limit to minimize functional deficit, but it has been demonstrated that the degree of angulation for closed boxer's fractures may not correlate with outcome and functional results.[3-5,7] Multiple studies have described the mobility of the fifth carpometacarpal joint, which accommodates up to 70 degrees of volar angulation.

Treatment

Conventionally, these fractures are treated with closed reduction and immobilization with a cast or splint. The rationale being that immobilization provides better alignment and may improve outcome measures. Closed reduction is done by applying longitudinal traction and dorsally directed force onto the head of the affected metacarpal. Immobilization is achieved with the use of ulnar gutter casts or splints that envelope the fourth and fifth digits in plaster on both the volar and dorsal aspects providing immobilization and protection of the fractured ray. This treatment method is offered to patients in most emergency departments with the duration of immobilization varying between surgeons, most of them removing the cast or splint by four weeks and converting it to buddy taping for controlled motion and initiation of guided therapy.[3-5,7]

The comparison between protected early mobilization with the use of buddy taping and cast immobilization in the treatment of fifth metacarpal neck fractures have both functional and socioeconomic significance. The cost difference due to the materials used and the ability of the patient to return to function and work while undergoing treatment, both have an effect to the aforementioned. Hence, this study aims to compare the patient-reported functional outcomes of the two interventions; as well as its effect on the number of days lost off work as a measure of economic consequence.

METHODOLOGY

Search Strategy

Literature search was conducted using online electronic databases: PubMed, Cochrane Library, Embase, Google Scholar and ScienceDirect

from inception to November 2022. Search terms included "Fifth Metacarpal Neck Fracture", "Boxer's Fracture", "Buddy Taping", "Splint Immobilization", "Ulnar Gutter Splint", "Randomized Controlled Trial."

Eligibility Criteria

Types of Studies

This meta-analysis includes randomized controlled trials comparing protected early mobilization with buddy taping and cast or splint immobilization of fifth metacarpal neck fractures.[3-5,7]

Participants

Eligibility criteria included adult patients with fifth metacarpal neck fractures or boxer's fractures diagnosed via orthogonal radiographs according to institute guidelines. Radiographic requirements included fracture angulations of less than 70 degrees, with no evidence of rotational deformity. Patients with gross rotational deformities, open fractures, concomitant fractures and/or tendon injuries to the same hand, metabolic bone diseases or recurrent fractures to the same metacarpal were excluded.[3-5,7]

Types of Intervention

Buddy taping of the affected fifth ray to the adjacent fourth digit as a form of immobilization that will allow protected early mobilization will be compared to immobilization using the ulnar gutter casts/splints.

Outcome

The Shortened Disability of the Arm, Shoulder, and Hand Score (quickDASH) was used to compare functional and pain outcomes between the two intervention groups. The quickDASH questionnaire contained 11 items that reflected the participant's ability to do everyday tasks and measured pain and disability because of the injury. The quickDASH questionnaire rates the patient's disability on a scale of 0 to 100, with higher scores indicating higher degrees of disability.

Data Collection and Analysis

Selection of Studies

The investigators conducted searches in online electronic databases PubMed, Cochrane Library, Embase, Google Scholar and ScienceDirect published in any language between 2015 and 2022. Studies eligible for inclusion should be randomized controlled trials comparing protected early mobilization with buddy taping and cast or splint immobilization of fifth metacarpal neck fractures. Only randomized controlled trials were used because these produce high quality data with the least bias.

Data Extraction

Data extraction was performed by one investigator and cross-checked by another. Data was documented on a data extraction template downloaded from the Cochrane Collection website to compare trial methods, participants, interventions and outcome measures for each study.

Assessment of Heterogeneity

The investigators identified heterogeneity by visual inspection of the Forrest plot and by statistical analysis of variance using the Chi-squared test based on the Cochrane handbook. The investigators made use of the guide recommended by the Cochrane handbook to interpret heterogeneity.

0% – 40%: Might not be important

30% -60%: May represent moderate heterogeneity

50% - 90%: May represent substantial heterogeneity

75% - 100%: Considerable heterogeneity

The importance of the observed value of I^2 will depend on the magnitude and direction of effects and strength of heterogeneity.

Assessment of Bias

The investigators assessed the risk of bias of each included study independently. Risk of bias was assessed using the Cochrane Collaboration's tool (Higgins 2011a; Higgins 2011b). Selection, performance, detection, reporting and attrition bias will be assessed using the following criteria:

- Random sequence generation

- Allocation concealment
- Blinding
- Incomplete outcome data
- Selective reporting

Data Analysis

Once sufficient information was extracted and outcome measures compared, meta-analysis was performed, allowing for a quantitative analysis of the studies. Statistical analysis was performed using the Review Manager (RevMan) version 5.4 software (The Nordic Cochrane Center, The Cochrane Collaboration, Copenhagen, Denmark, 2008), a P -value of less than 0.05 will be considered significant.

RESULTS

Literature Search and Evaluation

A total of 211 articles were identified through online searches of electronic databases (PubMed, Cochrane Library and Google Scholar) published in any language between 2015 and 2022. After exclusion of duplicate studies and studies with irrelevant topics, 75 articles remained. Of these 75 articles, 3 were excluded due to incorrect population, 31 due to inappropriate intervention and finally 38 were excluded due to improper study designs. After study attrition, four randomized control trials were enrolled in the meta-analysis. The flow of study attrition is shown in Figure 1.

The four articles enrolled included 248 patients with fifth metacarpal neck fractures, wherein 122 patients underwent buddy taping of the adjacent fifth and fourth digits, while 126 patients underwent splint immobilization, with or without closed reduction. The clinical demographics of the participants are shown in Table 1.

Treatment allocation in the four included articles was described by their authors and sufficient randomization techniques were described for each article. Blinding of the participants and personnel was not possible for the studies due to the nature of treatments. However, radiographic evaluation by the researchers were blinded. All four studies provided complete outcome data, including but not limited to quickDASH scores, Visual Analog Scale (VAS) scores and fracture angulations up until final follow-up. However, the study by Marquinez, et al., did not provide data regarding days off of work.

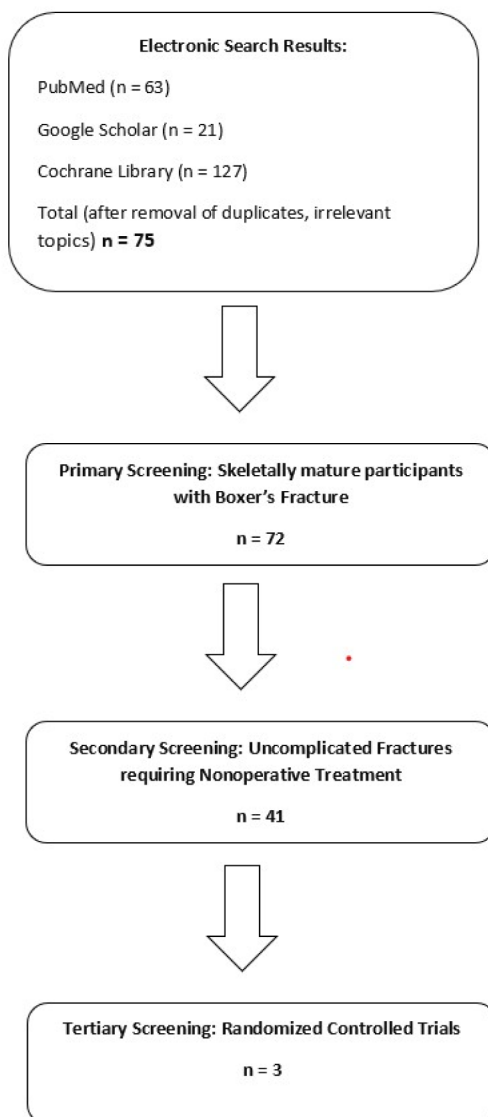


Figure 1 Flowchart of Study Attrition

Table 1 Characteristics of Studies in the Meta-analysis.

	Country	Years Included	Mean Age (PM/SI)	Number of Patients (PM/SI)	Study Design (PM/SI)	Follow up (Weeks) (PM/SI)
van Aaken (2015)	Switzerland and USA	2010-2013	29.6/27.2	20/19	RCT	16
Pellat (2019)	Australia	2016-2017	26/27	48/49	RCT	12
Martinez-Catalan (2020)	Spain	2016-2018	41/44	34/38	RCT	9
Marquinez (2021)	Spain	2019-2020	36.7/35.6	20/20	RCT	6

Outcome Measures

Functional Outcomes – the quickDASH score was used for primary outcome assessment for each of the four articles enrolled. Secondary outcomes included VAS scores and days off of work.

quickDASH Score – All four articles were included, with 247 patients all presenting with fifth metacarpal neck fractures. Meta-analysis results using the fixed effects model showed that there was a statistically significant difference in the quickDASH scores

Table 2 Risk of Bias Assessment of the Included Studies

	Random Sequence Generation	Allocation Concealment	Blinding of Participants and Personnel	Blinding of Outcome Assessment	Incomplete Outcome Data	Selective Reporting	Other Bias
van Aaken (2015)	High	Unclear	High	High	Low	Low	Low
Pellat (2019)	Low	Low	High	High	Low	Low	Low
Martinez-Catalan (2020)	Unclear	High	High	High	Low	Low	Low
Marquinez (2021)	High	Unclear	High	High	Low	Low	Low

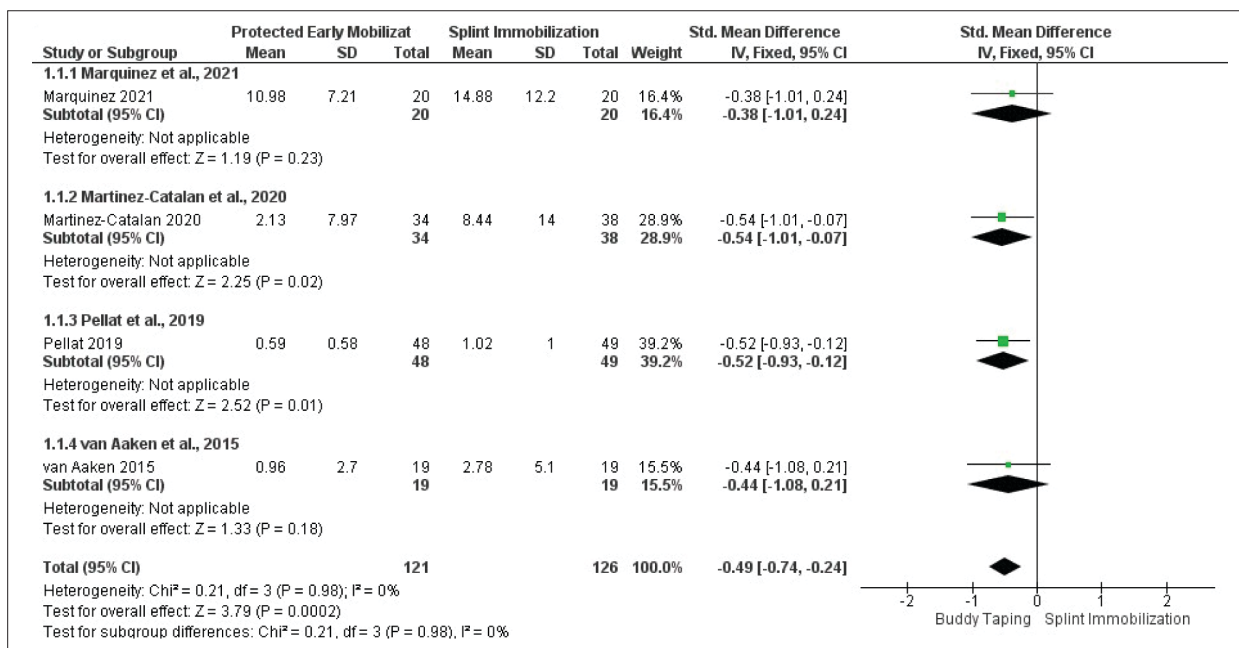


Figure 2 Forest Plot of quickDASH Scores.

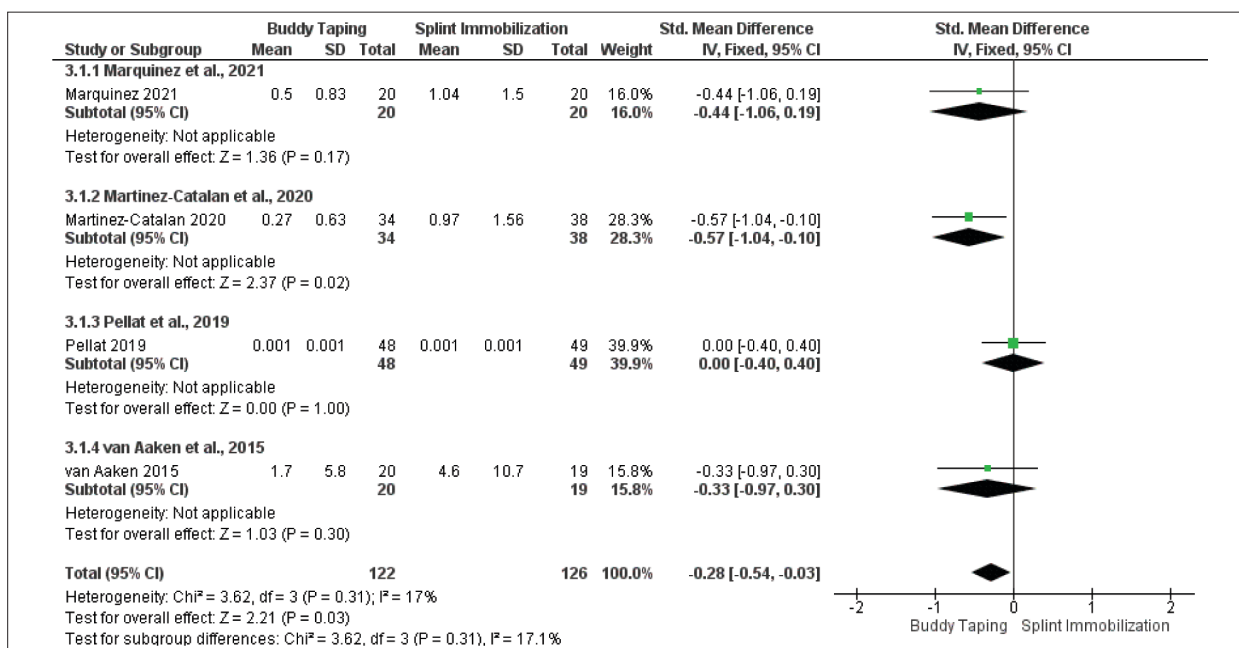


Figure 3 Forest Plot of VAS Scores

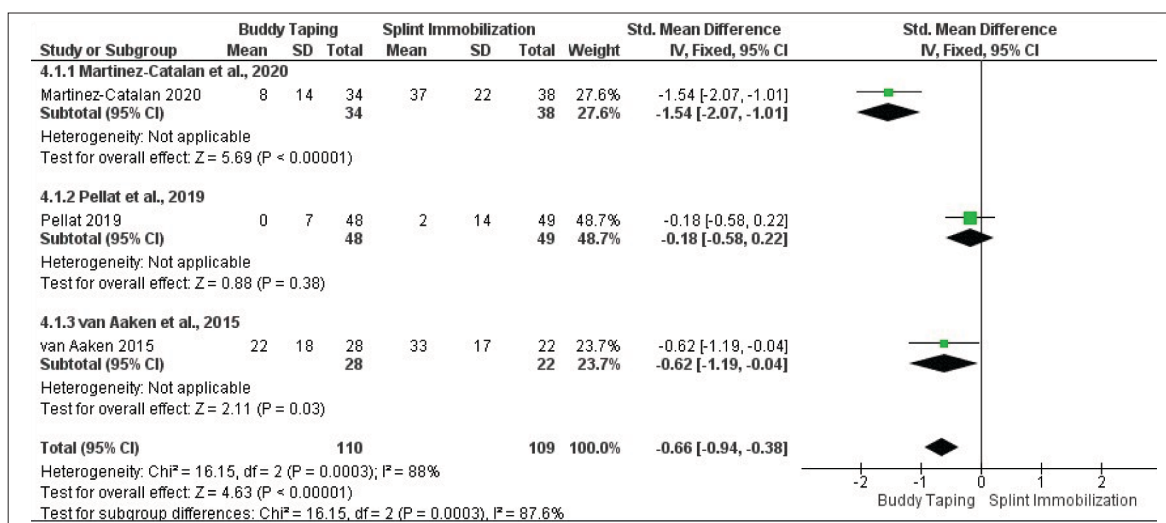


Figure 4 Forest Plot of Day Off of Work

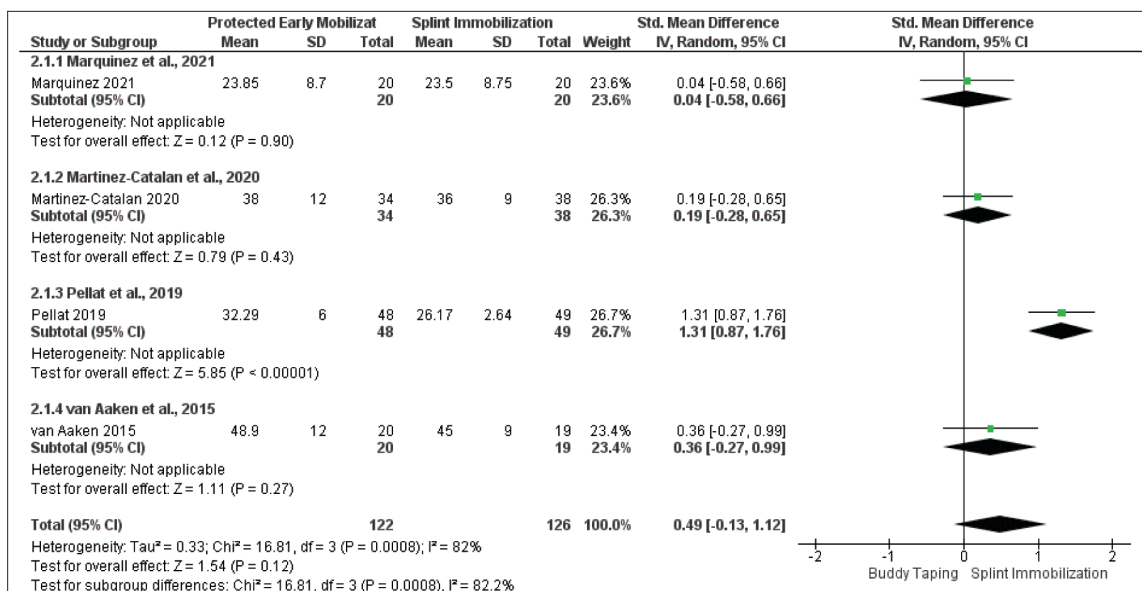


Figure 5 Forest Plot of Fracture Angulation

between the protected early mobilization with buddy taping group and the splint immobilization group (-0.49, 95% CI -0.74 to -0.24, P = 0.0002, I² = 0%).

VAS Score – All four articles were also compared regarding pain scores between the two populations using the VAS Pain Score scale. A total of 248 participants were included. Results of the meta-analysis using the fixed effects model showed that there was a statistically significant difference in the VAS scores between the protected early mobilization with buddy taping group and the splint immobilization group (-0.28, 95% CI -0.54 to -0.03, P = 0.03, I² = 17%).

Days Off of Work - Only three of the included articles measured the days of leave from work as a secondary functional outcome, yielding 219

participants. Results of the meta-analysis using the fixed effects model showed that there was a statistically significant difference in the days off of work between the protected early mobilization with buddy taping group and the splint immobilization group (-0.66, 95% CI -0.94 to -0.38, P < 0.00001, I² = 88%).

Radiographic Outcome – The radiographic outcome of each participant was measured using the fracture angulation at final follow-up. Data extracted from the studies allowed meta-analysis using the random effect model (P = 0.001, I² = 85%). The results showed no significant difference in fracture angulation between the protected early mobilization with buddy taping group and the splint immobilization group (0.49, 95%CI -0.13 to 1.12, P = 0.12).

DISCUSSION

Fifth metacarpal neck fractures have conventionally been treated with closed reduction and immobilization using ulnar gutter splints. This is in large part due to the belief that splint immobilization provided better outcomes in pain and function.[3] In recent years, however, buddy taping with protected early mobilization has been postulated to provide similar results. In their trial in 2021, Retrouvey, et al., found that patients who were treated with soft bandaging and early mobilization had higher grip strength as opposed to those treated with a splint, although functional outcomes were similar based on the brief Michigan Hand Questionnaire. This aligns with fundamental hand biomechanics and therapy principles, wherein early joint range of motion correlates to reduction in stiffness and therefore less pain. Furthermore, expeditious use of the hand reduces muscle atrophy, and consequently, improvement in strength measures.[6]

Functional outcomes measured using the quickDASH score showed a statistical difference between the two groups across four studies. In the trials included, we noted that quickDASH scores in the buddy taping group were lower compared to that of the splint immobilization group, suggesting decrease in pain and better ability to carry out activities of daily living. Worse hand function in the splint immobilization group may point to the discomfort of the more cumbersome ulnar gutter splint made from plaster. Stiffness of the fifth metacarpophalangeal joint attributed to prolonged splinting can also contribute to the perceived disability long after the splint is removed.[4,5,7,8] Mean quickDASH scores at final followup show a favoring of the buddy taping group, with lower scores compared to the standard. This may suggest that it allows faster recovery. VAS pain scores as secondary functional outcomes also favored the protected early mobilization group with lower pain scores at final follow-up. This indicated a higher proportion of participants in the splint

immobilization group that suffered from pain, even after several weeks of treatment. Days off of work as the final secondary outcome also showed significant improvement in the participants' ability to return to work in a shorter time in the buddy taping group which indicated faster recovery.

Radiographic outcomes measured by fracture angulation showed no significant difference across the four studies included, suggesting similar degrees of fracture angulation at final follow-up between the two groups. A review of studies included in the meta-analysis showed acceptable fracture angulation up to 70 degrees. This may allow the clinician to forego closed reduction prior to immobilization, whether he opts to immobilize using a splint or buddy taping.

Limitation of the Study

Potential limitations in this review must be acknowledged. First, analyses could be influenced by incomplete results; however, an extensive electronic database search was performed and funnel plots did not indicate evidence of publication bias. Second, we have included only four journals which have met the eligibility criteria for this study. Nevertheless, on the results, we noted no heterogeneity among the primary outcome and one of the secondary outcomes – VAS score. There is also acceptable heterogeneity of other secondary outcome results.

CONCLUSION

This meta-analysis concludes that protected early mobilization with buddy taping provides better functional outcomes in patients with fifth metacarpal neck fractures. Both quickDASH and VAS scores showed significant improvement favoring the buddy taping group. It also provided evidence that days off of work was significantly decreased in the same group and may provide practical implications as it is easier to apply and the cost is lower, conserving resources both in the emergency and orthopedic department.

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APPENDICES

Appendix 1. Search strategies

Search terms and databases

"Fifth metacarpal neck fracture", "Boxer's fracture", "Buddy taping", "Splinting", "Randomized controlled trial"

PubMed

The Cochrane Library

Google Scholar

Appendix 2 Description of intervention

Characteristic	Intervention	Adequate* intervention. [Yes/No]	Comparator	Adequate* intervention. [Yes/ No]
Study 1	Intervention 1 (Buddy Taping)	Yes	Intervention 1 (Splint Immobilization)	Yes
Study 2	Intervention 2 (Buddy Taping)	Yes	Intervention 2 (Splint Immobilization)	Yes
Study 3	Intervention 3 (Buddy Taping)	Yes	Intervention 3 (Splint Immobilization)	Yes
Study 4	Intervention 4 (Buddy Taping)	Yes	Intervention 4 (Splint Immobilization)	Yes

*The term 'adequate' refers to sufficient use of the intervention/comparator with regard to dose, dose escalation, dosing scheme, provision for contraindications and other features necessary to establish a fair contrast between intervention and comparator. N: no; Y: yes

Appendix 3 Baseline characteristics

	Country	Years Included	Mean Age (PM/SI)	Number of Patients (PM/SI)	Study Design (PM/SI)	Follow up (Weeks) (PM/SI)
van Aaken (2015)	Switzerland and USA	2010-2013	29.6/27.2	20/19	RCT	16
Pellat (2019)	Australia	2016-2017	26/27	48/49	RCT	12
Martinez-Catalan (2020)	Spain	2016-2018	41/44	34/38	RCT	9
Marquinez (2021)	Spain	2019-2020	36.7/35.6	20/20	RCT	6

Appendix 4 Study eligibility

RCT	Relevant participants	Relevant interventions	Relevant outcome
	Yes/No/Unclear	Yes/No/Unclear	Yes/No/Unclear
Study 1	Yes	Yes	Yes
Study 2	Yes	Yes	Yes
Study 3	Yes	Yes	Yes
Study 4	Yes	Yes	Yes

Appendix 5 quickDASH Questionnaire

QuickDASH

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	1	2	3	4	5
2. Do heavy household chores (e.g., wash walls, floors).	1	2	3	4	5
3. Carry a shopping bag or briefcase.	1	2	3	4	5
4. Wash your back.	1	2	3	4	5
5. Use a knife to cut food.	1	2	3	4	5
6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	1	2	3	4	5

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
7. During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	1	2	3	4	5

	NOT LIMITED AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	1	2	3	4	5

Please rate the severity of the following symptoms in the last week. (circle number)

	NONE	MILD	MODERATE	SEVERE	EXTREME
9. Arm, shoulder or hand pain.	1	2	3	4	5
10. Tingling (pins and needles) in your arm, shoulder or hand.	1	2	3	4	5

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	SO MUCH DIFFICULTY THAT I CAN'T SLEEP
11. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? (circle number)	1	2	3	4	5