

**EFFECTIVENESS OF BELOW ELBOW CAST AS
THE PRIMARY MODALITY IN
IMMOBILISATION OF DISTAL END RADIUS
FRACTURES: A SYSTEMATIC REVIEW AND
META-ANALYSIS**

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Dissertation Submitted in Partial Fulfilment of The
Requirements for The Degree of Master of Medicine
(ORTHOPAEDIC)



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LIST OF ABBREVIATIONS AND SYMBOLS

DERF	Distal end radius fracture
OR	Odds ratio
MD	Mean difference
<i>I</i>²	Heterogeneity test
PROSPERO	International Prospective Register of Systematic Reviews
BEC	Below elbow cast
AEC	Above elbow cast
CI	Confidence interval
RH	Radial height
RI	Radial inclination
VT	Volar tilt
JBI	Joanna Briggs Institute
RevMan	Review Manager
MM	Maria Mardi
EFM	Emil Fazliq Mohd
MAI	Md Asiful Islam
NA	Not applicable
NR	Not reported
<i>p</i>	p-value
DASH	Disability of The Arm and Shoulder
VAS	Visual analogue scale

ABSTRAK

Pengenalan

Patah hujung radius boleh dirawat secara konservatif apabila penjajaran yang boleh diterima diperolehi dengan manipulasi tertutup. Pelbagai jenis peralatan anduh telah digunakan untuk mengekalkan penjajaran kepatahan.

Objektif

Objektif kajian kami adalah untuk menyiasat keberkesanan kas bawah siku dalam memberikan hasil radiologi dan fungsian yang baik untuk kepatahan tulang ini, dan untuk memerhatikan kadar kelaziman kesan buruknya, berbanding dengan jenis peralatan anduh yang lain.

Kaedah Kajian

Kami mencari melalui pangkalan data dalam talian elektronik iaitu Google Scholar, Web of Science, Scopus, PubMed dan Cochrane, dan memasukkan 15 kajian dengan sejumlah 1373 pesakit untuk semakan sistematik dan meta-analisis. Model kesan rawak dengan selang keyakinan (CI) 95% telah digunakan dalam mengira perbezaan min (MD) dan nisbah kemungkinan (OR). Protokol yang dipratentukan telah didaftarkan dengan PROSPERO, sebuah pendaftaran prospektif antarabangsa untuk semakan sistematik, yang berpangkalan di University of York, United Kingdom (No Pendaftaran CRD42021231480).

Keputusan

Terdapat perbezaan ketara yang memihak kepada kas bawah siku dalam kebolehannya mencegah kehilangan penjajaran kepatahan berbanding dengan peralatan anduh lain (OR: 0.61; 95% CI: 0.38-0.98; $p=0.04$; $I^2=0\%$), juga khususnya jika dibandingkan dengan kas atas siku (OR: 0.50; 95% CI: 0.29-0.86; $p=0.01$; $I^2=0\%$). Hasil fungsian, iaitu skor Ketidakupayaan

Lengan, Bahu dan Tangan (DASH) dan skala analog visual (VAS), tidak menunjukkan perbezaan yang signifikan antara kas bawah siku dan peralatan anduh lain (DASH: MD: -0.11; 95% CI: -1.50 -1.28; $p=0.88$; $I^2=0\%$), (VAS: MD: 0.51; 95% CI: -0.19-1.20; $p=0.15$; $I^2=87\%$). Kelaziman kesan buruk adalah rendah dalam semua peralatan anduh, lebih-lebih lagi dengan kas bawah siku.

Kesimpulan

Keputusan kami menunjukkan bahawa kas bawah siku berfungsi sebagai pilihan terbaik untuk imobilisasi dalam patah hujung radius dalam orang dewasa tanpa menjejaskan hasil radiologi, sementara mempunyai kadar komplikasi yang rendah.

Keywords: *below elbow cast, distal end radius fracture, immobilisation, splinting, meta-analysis*

ABSTRACT

Introduction

Distal end radius fracture can be treated conservatively when acceptable alignment is obtained by closed manipulation. Different types of immobilisers have been used to maintain fracture reduction.

Objective

Our study objective was to investigate the effectiveness of below elbow cast in giving good radiological and functional outcomes in this fracture management, and to observe the prevalence of its adverse effects, compared to other type of immobilisers.

Methodology

We searched through electronic online databases namely Google Scholar, Web of Science, Scopus, PubMed and Cochrane, and included 15 studies with a total of 1373 patients for systematic review and meta-analysis. Random-effects model with 95% confidence interval (CI) was used in calculating the mean differences (MDs) and odds ratios (ORs). A predefined protocol was registered with PROSPERO, an international prospective registry for systematic reviews, based in University of York, United Kingdom (Registration No CRD42021231480).

Results

There was a significant difference in the percentage of loss of fracture reduction, favouring the below elbow cast group compared to other immobilisers (OR: 0.61; 95% CI: 0.38-0.98; $p=0.04$; $I^2=0\%$), also specifically when compared to above elbow cast (OR: 0.50; 95% CI: 0.29-0.86; $p=0.01$; $I^2=0\%$). Functional outcomes, namely the Disabilities of the Arm, Shoulder and Hand (DASH) and visual analogue scale (VAS) scores, showed no significant difference between

below elbow cast and other immobilisers (DASH: MD: -0.11; 95% CI: -1.50-1.28; $p=0.88$; $I^2=0\%$), (VAS: MD: 0.51; 95% CI: -0.19-1.20; $p=0.15$; $I^2=87\%$). The prevalence of adverse effects is generally low in all immobilisers, even more with below elbow cast.

Conclusion

Our results suggest that below elbow cast serves its purpose as the best option for immobilisation in adult distal end radius fractures without jeopardising radiological outcome, while having low complication rate.

Keywords: below elbow cast, distal end radius fracture, immobilisation, splinting, meta-analysis

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Distal end radius fracture has been one of the most common fractures that physicians and surgeons encountered since the earlier times. It is said to account for 1/6th of all the fractures seen coming through the emergency department in the United States (1).

This fracture most commonly results from a fall on the outstretched hand, and the different level of energy where this occurs gives a bimodal peak of incidence for this type of fracture. High energy injuries can cause fractures in the younger age group of 18-25 years, whereas low energy injuries will result in fractures in the more elderly, osteoporotic bones of more than 65 years of age (2).

Depending on the fracture pattern, distal end radius fractures can be labelled as stable and unstable. Lafontaine in his study in 1989 proposed an instability criteria for the distal end radius fracture: dorsal angulation more than 20 degrees, dorsal comminution, intra-articular radiocarpal fracture, associated ulnar fracture, and fractures involving elderly patients of more than 60 years of age (3). With these criteria in hand, the stable fracture patterns can be identified and suitably chosen for conservative treatment. Furthermore, adults with non-displaced extra-articular or intra-articular fractures, displaced fractures that remains stable after closed reduction and certain unstable fractures in the elderly age group in which surgeon accepts an amount of tolerable secondary displacement, are also preferable for the conservative treatment path (4).

Closed manipulation and reduction are first required to obtain an acceptable alignment of the fracture. Qualitative parameters have been studied since the 1950s, namely the volar tilt, radial inclination and radial height, and have until now been used as guideline for acceptable

alignment for the fracture reduction (5). These are associated with better functional outcomes of the patient in terms of grip strength, pain and range of motion (5).

In order to maintain the reduction, numerous different immobilization methods have been demonstrated by clinicians and surgeons. Previous authors have suggested the usage of removable splint for the entire course of treatment to maintain reduction (6-8); however, its ability to achieve this remains debatable, and the usage of circumferential cast until now remains as the recommended immobilization technique by the American Academy of Orthopaedic Surgeons (9). Furthermore, there is also the dilemma regarding the need for elbow immobilization to maintain reduction, and above elbow cast is specified as necessary, especially in non-osteoporotic bones, to lock the forearm in supination and neutralize the brachioradialis muscle pull that was originally considered responsible for any loss of reduction (10). However, many recent papers tend to dispute this theory and conclude that elbow immobilization does not affect the risk of displacement (11-14).

Currently, a below elbow cast is typically used in osteoporotic distal end radius fractures (12). It is applied just distal to the elbow crease, covering up till just proximal to the knuckle area, allowing full range of motion of the elbow and metacarpophalangeal joints. This immobiliser is more pleasant, easy to manage by patient, lightweight and easy to be applied (14). Thus, with the more recent reviews, this cast should be broadly used in all distal end radius fractures and not confined to osteoporotic bones only. If the below elbow cast is as effective as the other immobilization methods, it should be standardly used as the primary immobilization in all distal end radius fractures, providing enough rigidity to maintain reduction, yet not too cumbersome and less complication to the patients.

1.2 OBJECTIVE

General

The objective of this study was to analyse the effectiveness of below elbow cast in providing good radiological and functional outcomes in conservative treatment of all types of distal end radius fractures in adults and to identify the prevalence of adverse effects that might occur with it compared to other immobilisers.

Specific

1. To determine odds ratio for loss of fracture reduction between below elbow cast and other immobilisers, collectively and individually
2. To identify mean differences of loss of radial height, radial inclination and volar tilt between below elbow cast and other immobilisers, collectively and individually
3. To identify mean differences of DASH and VAS scores between below elbow cast and other immobilisers
4. To determine the prevalence of adverse effects in different type of immobilisers

CHAPTER 2: STUDY PROTOCOL

2.1 METHOD

2.1.1 Study Design

This systematic review and meta-analysis will be carried out using the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines and recommendations to determine the mean differences and odds ratio of radiological and functional outcomes when using below elbow cast in conservative treatment of distal end radius fracture compared to other type of immobilisers. This research protocol will be registered to PROSPERO (an international database of prospectively registered systematic reviews), University of York, York.

2.1.2 Eligibility Criteria

- **Types of Study**

This study plans to include both observational and clinical trials as there is plan for restriction to the study design. Preprints are also to be included provided data of interest has been reported. Studies published with identical authors will be managed with extra vigilance to ensure that there is no duplication of data. Review articles, meta-analyses, case reports, case series, letters, editorials, comments, and animal studies will be excluded.

- **Types of Participants**

All types of distal end radius fractures that is treated conservatively with immobilisation will be included in this study. All age group are included and not confined to osteoporotic fractures only, including both genders and all races. Both intra-articular and extra-articular fractures are also included.

- **Types of Interventions**

Distal end radius fractures that are treated conservatively with below elbow cast and any other type of immobiliser such as cast, splint or bandage will be included. Fractures that are treated surgically will be excluded.

- Type of Outcomes

This meta-analysis aims to estimate the effectiveness of below elbow cast in immobilisation of distal end radius fracture with regards to radiological outcomes (loss of reduction, loss of radial height, radial inclination and volar tilt) and functional outcomes (DASH and VAS scores).

Secondary outcome includes estimating the prevalence of adverse effects in below elbow cast usage in distal end radius fracture in comparison with other immobilisers.

2.1.3 Search Strategies

- Electronic Searches

We will search the electronic online databases such as PubMed, Scopus, Web of Science, Google Scholar and Cochrane Central Register of Controlled Trials (CENTRAL) to identify studies that are suitable to be included in the systematic review and meta-analysis. A final systematic search will be run again prior to commencing of data analysis, to ensure no study was missed during the earlier search. Complete details of the search strategy are included in the Appendix section.

- Keywords

The following keywords will be used to construct the search strategies:

1. Distal radius-associated

Distal radius, distal radial, Colles fracture, Colles fractures, Barton fracture, Barton fractures, Smith fracture, Smith fractures, wrist fracture

2. Cast-associated

Cast, casts, casting, immobilization, immobilisation

2.1.4 Study Selection

Two authors (MM and EFM) will screen the article's title and abstract independently and select the articles to be included based on the eligibility criteria. Disagreements concerning inclusion will be discussed and resolved by consensus with the third author (MAI). EndNote software (Version 20) will be used to eliminate duplicate studies from various databases. In addition, references in the primary articles will be screened to determine any additional relevant studies.

2.1.5 Data Extraction

Data extraction will be done by one author (MM) and cross-checked by the other authors (EFM and MAI). Google Translate service will be used for any non-English study for its translation to the English language, later on to be validated by a native speaker. From each eligible study, we will extract the information that were required and table it into an Excel spreadsheet. These are namely: first author's last name, year of study publication, study duration, study design, number of participants, number of participants of each gender, age group, type of distal end radius fracture, duration and position of immobilisation, the final radial height, the final radial inclination, the final volar tilt, percentage of loss of reduction, the DASH scores, the VAS score, the percentage of range of motion of the wrist and forearm and the prevalence of complications following the casts techniques. When any of the required data was incompletely reported or in unusable format, the original authors will be contacted via email or through researchers networking site in order to obtain usable data. In the event of failure to contact the original authors, required data can be calculated using the formulas recommended by the Cochrane handbook.

2.1.6 Quality Assessment

The quality of all the included studies will be independently assessed by two authors (MM and EFM) using the Joanna Briggs Institute (JBI) critical appraisal tools for cohort studies and randomised control trials (RCTs). Afterwards, any difference in quality assessment results will be discussed with a third author (MAI) to ensure that the discrepancy is resolved. The studies are divided into low quality if overall quality score is <50% (high risk of bias), moderate quality if score is 50-70% and high quality if overall quality score is >70%.

2.1.7 Statistical Analysis

- Data Synthesis

The primary outcome will be determined by the radiological parameters namely percentage of participants with loss of reduction, the final values of radial height, radial inclination and volar tilt. The secondary outcome will be the functional parameters namely: percentage of range of motion, Disabilities of the Arm, Shoulder and Hand (DASH) score, visual analogue scale (VAS) score and complications following casts. The odds ratios (ORs) and mean differences (MDs) for all the parameters will be calculated with 95% confidence interval (CI) and using the random-effect model. RevMan (version 5.4) will be used to generate forest plots and metaprop codes in meta (version 4.15-1) and metafor (version 2.4-0) packages of R (version 3.6.3) in RStudio (version 1.3.1093) software (RStudio, Inc., Boston, MA, USA).

- Assessment of Heterogeneity

Any significant heterogeneity can be assessed by I^2 statistic in order to identify large variability that may affect the results ($I^2 > 75\%$ indicates substantial heterogeneity, $I^2 < 50\%$ shows no significant heterogeneity).

- Subgroup Analysis

Further subgroup analyses will also be made to obtain more specific results and identify other immobilisers that might have less complications than below elbow cast. Here, below elbow cast group will be compared separately to different types of comparators, namely above elbow cast, volar dorsal splint, reverse sugar tong splint, volar splint, dorsal splint, bandage and functional splint, for all of the outcomes as mentioned above.

- Sensitivity Analysis

We will conduct sensitivity analyses in order to detect the source of heterogeneity and to check the robustness of the results. It will be done by the leave-one-out method (remove one study and then repeat the analysis).

2.2 CONTRIBUTION OF AUTHORS

Designing the review	:	Maria Mardi, Emil Fazliq Mohd
Co-ordination of review	:	Maria Mardi, Md Asiful Islam
Literature search	:	Maria Mardi, Emil Fazliq Mohd
Literature translation	:	Maria Mardi
Quality assessment	:	Maria Mardi, Emil Fazliq Mohd, Md Asiful Islam
Entering data into RevMan	:	Md Asiful Islam
Data analysis	:	Maria Mardi, Emil Fazliq Mohd
Data interpretation	:	Maria Mardi, Emil Fazliq Mohd, Md Asiful Islam
Writing the review	:	Maria Mardi, Emil Fazliq Mohd, Md Asiful Islam

2.3 APPENDIX

2.3.1 Search Strategy

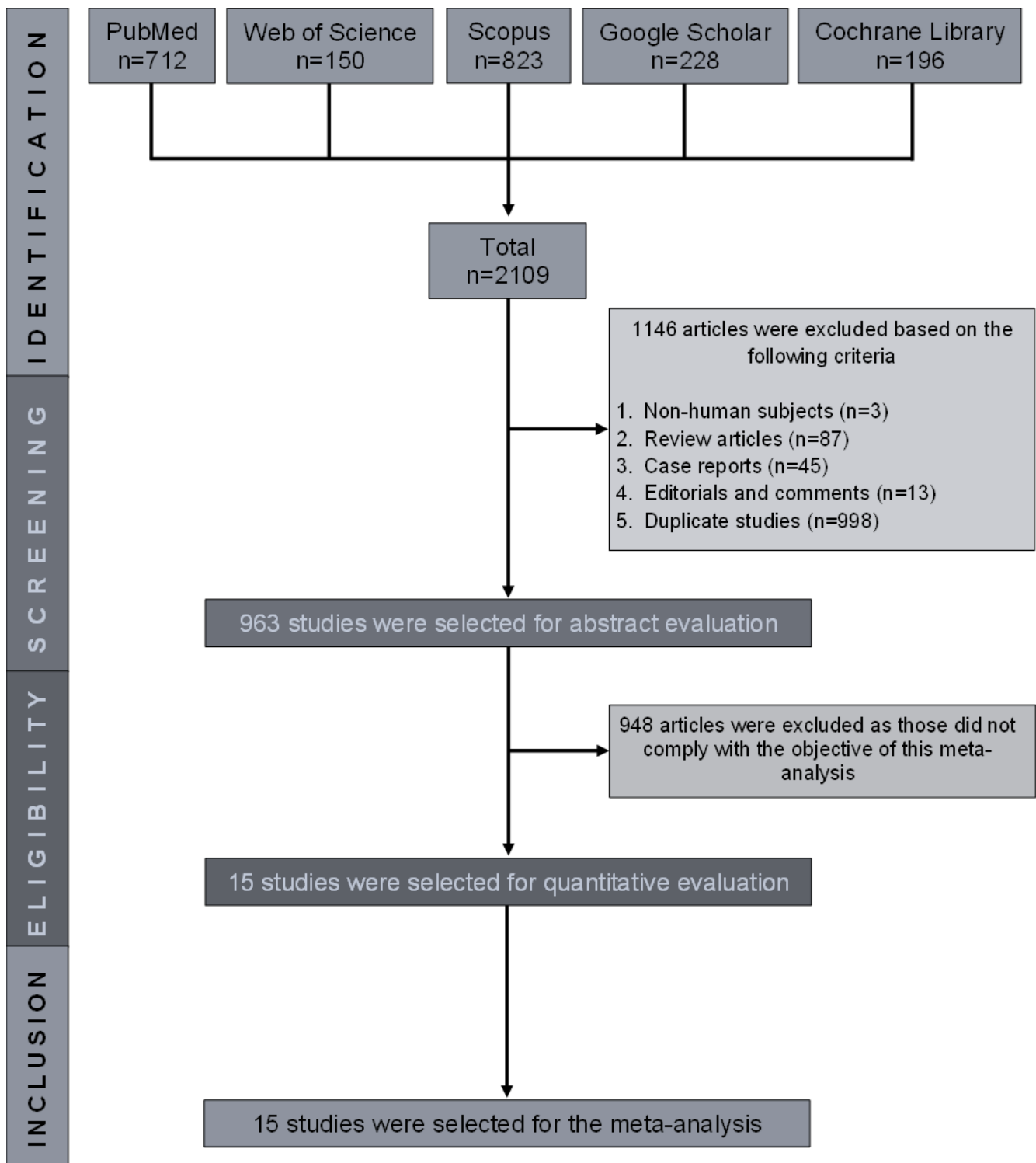
Databases	Search Strategy
PubMed	(distal radius[Title] OR distal radial[Title] OR Colles fracture[Title] OR Colles fractures[Title] OR Smith fracture[Title] OR Smith fractures[Title] OR Barton fracture[Title] OR Barton fractures[Title] OR wrist fracture[Title]) AND (cast[Title/Abstract] OR casts[Title/Abstract] OR casting[Title/Abstract] OR immobilization[Title/Abstract] OR immobilisation[Title/Abstract])
Web of Science	TI=(distal radius OR distal radial OR Colles fracture OR Colles fractures OR Smith fracture OR Smith fractures OR Barton fracture OR Barton fractures OR wrist fracture) AND TI=(cast OR casts OR casting OR immobilization OR immobilization) Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years
Scopus	TITLE("distal radius" OR "distal radial" OR "Colles fracture" OR "Colles fractures" OR "Smith fracture" OR "Smith fractures" OR "Barton fracture" OR "Barton fractures" OR "wrist fracture") AND TITLE-ABS(cast OR casts OR casting OR immobilization OR immobilization)
Google Scholar	allintitle:(distal radius OR distal radial OR Colles fracture OR Colles fractures OR Smith fracture OR Smith fractures OR

	Barton fracture OR Barton fractures OR wrist fracture) (cast OR casts OR casting OR immobilization OR immobilization)
Cochrane Library	((distal radius OR distal radial OR Colles fracture OR Colles fractures OR Smith fracture OR Smith fractures OR Barton fracture OR Barton fractures OR wrist fracture) (cast OR casts OR casting OR immobilization OR immobilization));ti

2.3.2 Data Collection Sheet

No	Study ID	Country	Study Design	Study Duration (months)	Total Sample Size	Age Group (years)	Type of Distal Radius Fracture	Below Elbow Cast				Other Immobilisers				
								Duration Immobilised (weeks)	Sample Size (M:F)	Age (years) (mean $\pm$ SD/ range)	Position Immobilised	Type of Immobiliser	Duration Immobilised (weeks)	Sample Size (M:F)	Age (years) (mean $\pm$ SD/ range)	Position Immobilised

2.3.3 Flow Chart



2.4 ETHICAL EXEMPTION LETTER



Jawatankuasa Etika
Penyelidikan Manusia USM (JEPeM)
Human Research Ethics Committee USM (HREC)

21st March 2021

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JEPeM Code : USM/JEPeM/21030233

Protocol Title : Distal Radius Fracture Immobilisation using Below Elbow Cast as Primary Modality: A Systematic Review and Meta-Analysis.

Dear Dr.,

We wish to inform you that the Jawatankuasa Etika Penyelidikan (Manusia), JEPeM USM has reviewed your study protocol entitled, "Distal Radius Fracture Immobilisation using Below Elbow Cast as Primary Modality: A Systematic Review and Meta-Analysis".

Upon review of study protocol, the committee decided that this project can be exempted from ethical review. Should you require any additional information, kindly please contact JEPeM USM Secretariat at 09-7672354/2352 and email at bazlan@usm.my/ctfatihah@usm.my.

Thank you.

"ENSURING A SUSTAINABLE TOMORROW"

Very truly yours,

PROF. DR. HANS AMIN VAN ROSTENBERGHE
Chairperson
Jawatankuasa Etika Penyelidikan (Manusia) JEPeM
Universiti Sains Malaysia

CHAPTER 3: MANUSCRIPT

**EFFECTIVENESS OF BELOW ELBOW CAST AS THE PRIMARY MODALITY IN
IMMOBILISATION OF DISTAL END RADIUS FRACTURES: A SYSTEMATIC
REVIEW AND META-ANALYSIS**

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**EFFECTIVENESS OF BELOW ELBOW
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3.1 ABSTRACT

Distal end radius fracture (DERF) can be treated conservatively when acceptable alignment is obtained by closed manipulation and reduction maintained by different types of immobilisers.

Aims: Our study objective was to investigate the effectiveness of below elbow cast (BEC) in giving good radiological and functional outcomes in this fracture management, and to observe the prevalence of its adverse effects, compared to other type of immobilisers.

Methods: We searched through electronic online databases namely Google Scholar, Web of Science, Scopus, PubMed and Cochrane, and included 15 studies with a total of 1373 patients for systematic review and meta-analysis. Random-effects model with 95% confidence interval (CI) was used in calculating the mean differences (MDs) and odds ratios (ORs).

Results: There was a significant difference in the percentage of loss of fracture reduction, favouring the below elbow cast group compared to other immobilisers (OR: 0.61; 95% CI: 0.38-0.98; $p=0.04$; $I^2=0\%$), also specifically when compared to above elbow cast (AEC) (OR: 0.50; 95% CI: 0.29-0.86; $p=0.01$; $I^2=0\%$). Functional outcomes, namely the Disabilities of the Arm, Shoulder and Hand (DASH) and visual analogue scale (VAS) scores, showed no significant difference between BEC and other immobilisers (DASH: MD: -0.11; 95% CI: -1.50-1.28; $p=0.88$; $I^2=0\%$), (VAS: MD: 0.51; 95% CI: -0.19-1.20; $p=0.15$; $I^2=87\%$). The prevalence of adverse effects is generally low in all immobilisers, even more with BEC.

Conclusion: Our results suggest that BEC serves its purpose as the best option for immobilisation in adult DERFs without jeopardising radiological outcome, while having low complication rate.

Keywords: below elbow cast, distal end radius fracture, immobilisation, splinting, meta-analysis

3.2 INTRODUCTION

Distal end radius fracture has been one of the most common fractures that physicians and surgeons encountered since the earlier times. It is said to account for 1/6th of all the fractures seen coming through the emergency department in the United States (1).

This fracture most commonly results from a fall on the outstretched hand, and the different level of energy where this occurs gives a bimodal peak of incidence for this type of fracture. High energy injuries can cause fractures in the younger age group of 18-25 years, whereas low energy injuries will result in fractures in the more elderly, osteoporotic bones of more than 65 years of age (2). Depending on the fracture pattern, distal end radius fractures can be labelled as stable and unstable. Lafontaine in his study in 1989 proposed an instability criteria for the distal end radius fracture: dorsal angulation more than 20 degrees, dorsal comminution, intra-articular radiocarpal fracture, associated ulnar fracture, and fractures involving elderly patients of more than 60 years of age (3). With these criteria in hand, the stable fracture patterns can be identified and suitably chosen for conservative treatment. Furthermore, adults with non-displaced extra-articular or intra-articular fractures, displaced fractures that remains stable after closed reduction and certain unstable fractures in the elderly age group in which surgeon accepts an amount of tolerable secondary displacement, are also preferable for the conservative treatment path (4). Closed manipulation and reduction are first required to obtain an acceptable alignment of the fracture. Qualitative parameters have been studied since the 1950s, namely the volar tilt, radial inclination and radial height, and have until now been used as guideline for acceptable alignment for the fracture reduction (5). These are associated with better functional outcomes of the patient in terms of grip strength, pain and range of motion (5).

In order to maintain the reduction, numerous different immobilization methods have been demonstrated by clinicians and surgeons. Previous authors have suggested the usage of removable splint for the entire course of treatment to maintain reduction (6-8); however, its

ability to achieve this remains debatable, and the usage of circumferential cast until now remains as the recommended immobilization technique by the American Academy of Orthopaedic Surgeons (9). Furthermore, there is also the dilemma regarding the need for elbow immobilization to maintain reduction, and above elbow cast is specified as necessary, especially in non-osteoporotic bones, to lock the forearm in supination and neutralize the brachioradialis muscle pull that was originally considered responsible for any loss of reduction (10). However, many recent papers tend to dispute this theory and conclude that elbow immobilization does not affect the risk of displacement (11-14). So, the lightweight, more pleasant and easier to apply below elbow cast should be broadly used in all distal end radius fractures and not confined to osteoporotic bones only. If the below elbow cast is as effective as the other immobilization methods, it should be standardly used as the primary immobilization in all distal end radius fractures, providing enough rigidity to maintain reduction, yet not too cumbersome and less complication to the patients.

Thus, the objective of this study was to analyse the effectiveness of below elbow cast compared to other immobilisers in terms of radiological and functional outcomes and to identify the prevalence of adverse effects that might occur with it compared to other immobilisers.

3.3 METHODOLOGY

Systematic Review Protocol

This systematic review and meta-analysis is written based on the guidelines produced by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) (15). A predefined protocol was registered with PROSPERO, an international prospective registry for systematic reviews, based in University of York, United Kingdom (Registration No CRD42021231480).

Eligibility Criteria

This study included both observational studies and clinical trials as there was no restriction applied to the study design. In addition, we included preprints as well provided that the data of interest has been reported. Studies that were published by identical authors were managed with extra vigilance, and if the study population is confirmed to be different then the studies are included. All studies included should use below elbow cast as the immobilisation technique for distal radius fracture. The comparator group may include any type of immobilisation technique, excluding any form of surgical intervention. The study population that is considered as eligible are adults of any age group, gender and races that are having any type of distal end radius fracture.

Search Strategies

Electronic online databases namely PubMed, Scopus, Web of Science, Google Scholar and Cochrane Central Register of Controlled Trials (CENTRAL) were thoroughly searched to identify studies that are suitable to be included in the systematic review and meta-analysis. No restrictions were made with regards to language or publication year. The final systematic search was done again on 21st November 2021 just before the commencement of data analysis, to

ensure no study was missed during the earlier search, which was done 9 months prior. The complete details of the search strategy are described in Table S1.

Case reports, review articles, animal studies, cadaveric studies and meeting abstracts were excluded. Duplicate studies were removed and managed using EndNote software (Version 20). The reference lists of primarily identified studies were also checked to find studies that were not identified by the electronic search.

Study Selection

The list of studies that came up from the search strategy was screened and eligible studies were identified based on the title and abstract. If further information were required to ensure eligibility, the full text article will be obtained and thoroughly examined, where the eligibility is then decided.

Data Extraction

Data extraction was done by MM and cross-checked by the other authors (EFM and MAI). Google Translate service has been used for any non-English study for its translation to the English language, later on a native speaker is asked to validate it. From each eligible study, we extracted the information that were required for a thorough systematic review and meta-analysis to be done, and tabled it into an Excel spreadsheet. These are namely: first author's last name, year of study publication, study duration, study design, number of participants, number of participants of each gender, age group, type of distal end radius fracture, duration and position of immobilisation, the final radial height, the final radial inclination, the final volar tilt, percentage of loss of reduction, the DASH scores, the VAS score, the percentage of range of motion of the wrist and forearm and the prevalence of complications following the casts techniques. When any of the required data was incompletely reported or in unusable format,