

Development of a clinical hand rehabilitation guideline for second to fifth metacarpal fracture rehabilitation: A Delphi method

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Abstract

Introduction: Metacarpal fractures are viewed as minor injuries, potentially leading to reduced hand function and productivity, especially in working-age people. The study aimed to develop and finalise a second to fifth metacarpal fractures clinical hand rehabilitation guideline.

Methods: A three-round eDelphi method, employing REDCap questionnaires and informed by a previous clinical hand rehabilitation guideline, facilitated expert consensus. Experience and qualifications guided expert selection. Consensus was defined as 75% or more experts selecting four or five on a Likert scale or 'yes' in 'yes/no' questions. Open-ended responses were incorporated, following Conducting and Reporting of Delphi Studies recommendations.

Results: Fifteen experts specialising in hand injury management, including orthopaedic surgeons, occupational therapists and physiotherapists, were invited to participate, with attrition of one expert in three rounds. In Round 1, 10 (28.5%), Round 2, 6 (18%) and Round 3, 16 (36%) guideline statements were accepted. Consensus was reached for including grasp types in rehabilitation; activities of daily living (ADLs) types under light, medium and heavy categories; time when early active mobilisation should commence and splint types after conservative management, K-wires and surgical fixation.

Conclusion: The finalised clinical hand rehabilitation guideline based on the Occupational Therapy Intervention Process Model (OTIPM) framework may benefit occupation return.

Keywords

Boxer's fracture/s, Delphi method, guidelines, metacarpal fractures, rehabilitation

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Introduction

Second to fifth metacarpal fractures account for 88% of metacarpal fractures, with the fifth metacarpal injured most often (Gudmundsen and Borgen, 2009). Fractures of the neck of the fifth metacarpal (Boxer's fractures) account for 20% of hand fractures, occurring mainly in working-age people, which leads to time off work and negative socioeconomic implications (Poolman et al., 2005), necessitating the need for evidence-based rehabilitation informing effective management.

Effective management of metacarpal fractures is crucial for ensuring not only the stability of the fracture and patient comfort but also facilitating early hand movement and a timely return to work for those individuals who have experienced such injuries (Toemen and Midgley, 2010). Hand rehabilitation plays a pivotal role in both post-surgical and conservative approaches to metacarpal fracture management, as emphasised by Mennen and Van Velze (2008) and Cooper and Wietlisbach (2014). This comprehensive rehabilitation process encompasses a range of essential components, including muscle stretches, management of wounds and surgical scars, oedema control, joint mobilisation and exercises that

involve the coordinated use of the affected hand in functional tasks such as dressing, eating, washing and other daily tasks. Additionally, the utilisation of external tools like therapeutic putty, bottles, balls, pegs, and elastics is integrated into the rehabilitation programme (Cooper and Wietlisbach, 2014; Mennen and Van Velze, 2008). Recent research by Geete et al. (2022) highlights the cognitive aspect of hand rehabilitation. They discovered that the ability to cognitively orientate the limb, known as hands laterality, can be adversely affected after a brief period of immobilisation. Given that

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initial management of metacarpal fractures typically involves splinting and immobilisation, addressing this aspect of rehabilitation becomes imperative. By doing so, we can enhance the overall effectiveness of the rehabilitation process and provide a more holistic approach to metacarpal fracture management. Fisher and Jones (2017) emphasise the importance of promoting professional reasoning that is occupation-centred, and evaluations and interventions that are occupation-focused. The OTIPM, in its client-centred and occupation-based approach, highlights the evaluation and goal-setting, the intervention- and re-evaluation phases are therefore considered in the guideline development towards second to fifth metacarpal fracture rehabilitation.

For the past 10 years of literature, the rehabilitation trends for second to fifth metacarpal fractures are moving towards immediate active mobilisation, immediate passive mobilisation, early mobilisation and early return to light functions (Al-Qattan, 2008; Gamble et al., 2015; Gülke et al., 2018; Kaynak et al., 2019; Midgley and Toemen, 2011; Platt et al., 2021; Toemen and Midgley, 2010; Van Aaken et al., 2016). Apart from Toemen and Midgley (2010), in their systematic review and evaluation of developed pathways (Midgley and Toemen, 2011), available programmes are not backed by high-quality systematic reviews or scientific evidence to guide rehabilitation and optimise outcomes, such as hand function, grip strength and optimal range of motion. A challenge thus is the lack of best-evidence guidelines for managing second to fifth metacarpal fractures, potentially leading to disability for individuals at a personal, family and community level. The authors subsequently discovered the paucity of research and sourced high-level evidence on hand rehabilitation programmes, splinting and immobilisation approaches in two systematic review publications (Keller et al., 2021, 2022a). The systematic review of Keller et al. (2021) focused on determining the best evidence-based hand rehabilitation programmes available. Keller et al. (2022a) reviewed, appraised and collated splinting and immobilisation types and timelines. Limited well-designed, methodological rigour and effectiveness evidence could be found in both reviews, with no review since 2008 conducted. In a separate phase of the study, the researcher determined the predominant grasp types and the finger forces during daily tasks. These test results were used to guide a patient to an earlier return to movement, while the identified grasp types were used to improve hand function and, as such, the commencement of an early but careful return to ADLs. This data was extracted for the compilation of the preliminary clinical hand rehabilitation guideline to be further developed and finalised in this eDelphi method.

The Delphi method, according to Taylor (2020), is a process used to gain consensus from a panel of experts through controlled feedback. The Delphi method sometimes referred to as a Delphi process or Delphi technique, is a systematic, structured, and scientifically accepted method used in

healthcare and has increased in popularity from the early 2000's (Taylor, 2020). Taylor (2020) states that the Delphi method is 'well suited to developing evidence-based design recommendations and considerations for healthcare-built environments'. Further, to develop the guideline, constructivist epistemology was the guiding paradigm, where the eDelphi method incorporated the views of expert participants to bring their unique experiences in hand injury rehabilitation.

The eDelphi method, presented in this study, aimed to finalise a clinical hand rehabilitation guideline for second to fifth metacarpal fractures post-surgical or conservative management.

Methods

An eDelphi method was used to further develop and complete a clinical hand rehabilitation guideline through purposively sampled expert orthopaedic surgeons, PTs and OTs, working in the field of hand injuries, hand surgery and rehabilitation.

The researcher compiled a preliminary clinical hand rehabilitation guideline, following the Appraisal of Guidelines for Research and Evaluation II (AGREE II) reporting checklist (Brouwers et al., 2010) to promote hand function and earlier return to ADLs. The guideline was based on the systematic reviews and scientific testing of all 10 fingers with force sensing resistors (FSRs), determining the maximum forces produced during 105 everyday tasks (Keller et al., 2022b). The FSR testing followed after the researcher identified the lack of scientific evidence informing therapists' practice about types and timelines for return to ADLs after sustaining second to fifth metacarpal fractures. The scientific force testing guided the differentiation of light, medium and heavy tasks that were included in the guideline. The researcher identified the predominant grasp type used during the daily tasks using ADL observations of the hand and the Disabilities of the Arm, Shoulder and Hand (DASH). The researcher identified the most predominant grasp type per ADL, which allowed for grasp-type exercises to be included in the guideline to progressively rehabilitate individuals towards functional return even before returning to the ADLs. The grasp-type exercises with splint and immobilisation types and timelines and return to basic and instrumental ADLs were compiled into a preliminary guideline before the eDelphi study. This eDelphi study with experts remained the final study to iteratively develop, reach a consensus and finalise the clinical hand rehabilitation guideline.

It is supported by Taylor (2020) that Delphi rounds continue until consensus has been reached. In this study, three eDelphi rounds were sufficient to reach consensus, adapt and finalise the clinical hand rehabilitation guideline for individuals who sustained second to fifth metacarpal fractures.

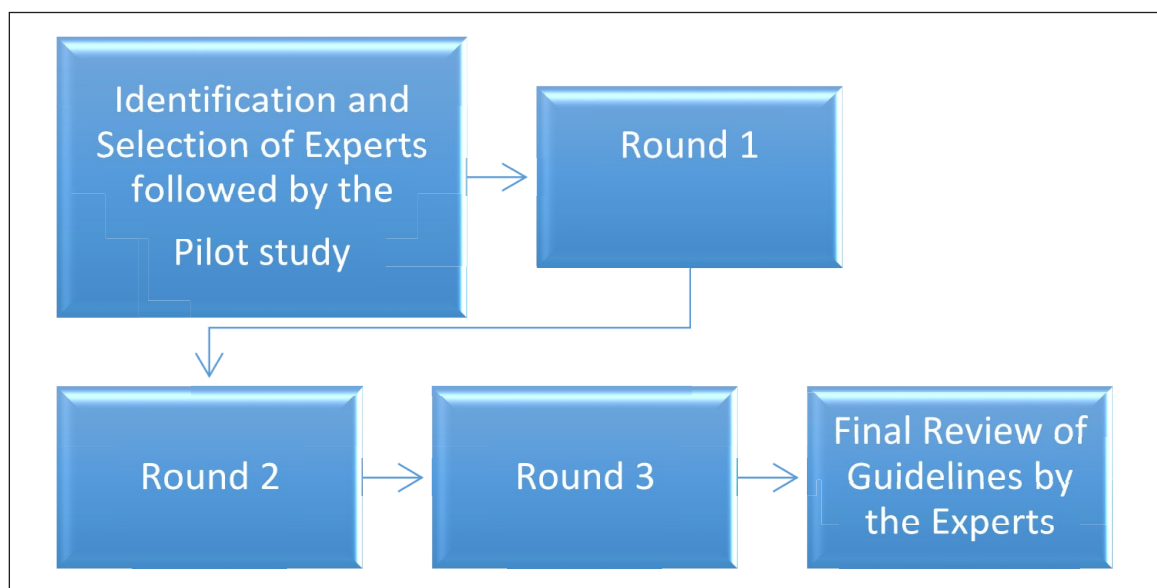


Figure 1. eDelphi process flow chart.

Table 1. Inclusion criteria for expert selection.

Orthopaedic surgeons	Occupational Therapists	Physiotherapists
Orthopaedic surgeons with a specialisation in hands Has at least two peer-reviewed published articles in the field of hand surgery Has a minimum of 5 years' experience in hands Has authored textbooks about hand injuries Holds a postgraduate degree in hand surgery Has been a presenter at one or more conferences where the topic relates to hand injuries	Occupational therapists with a specialisation in hand therapy At least two published articles in an accredited peer-reviewed journal in the field of hand therapy Has a minimum of 5 years' experience in the treatment of hand injuries Has authored textbooks or a chapter in a book based on hand injuries Holds a postgraduate degree (Masters/ PhD)/ Has certified hand therapy credentials Has been a speaker at one or more conferences where the topic relates to hand injuries	Physiotherapists with a specialisation in hand therapy At least two published articles in an accredited peer-reviewed journal in the field of hand therapy Has a minimum of 5 years' experience in the treatment of hand injuries Has authored textbooks or a chapter in a book based on hand injuries Holds a postgraduate degree (Masters/ PhD)/ Has certified hand therapy credentials Has been a speaker at one or more conferences where the topic relates to hand injuries

Consensus is the primary aim of the eDelphi method, but according to the literature, consensus measurement varies (Von der Gracht, 2012). For the purpose of this study, at least 75% of the panel of experts must have demonstrated the same preference for the clinical hand rehabilitation guideline recommendation before consensus could be reached (Van de Ven-Stevens et al., 2015). For the items where no consensus was reached after the first round, a second round was initiated, with a subsequent third and final round, to achieve the objectives of the study but also to avoid sample fatigue. The flow chart of the eDelphi method is presented in Figure 1.

Participants of the eDelphi panel

Expert identification preceded the panel selection. Study quality was enhanced by ensuring heterogeneity among the expert panel by including experts from different fields of hand rehabilitation. The author aimed to select the ideal panel: a third of

the participants' orthopaedic surgeons, a third OTs and a third PTs, all of whom had a special interest in hand surgery and hand rehabilitation. Experts were identified by the researcher through a search of the academic literature sources in the systematic reviews (Keller et al., 2021, 2022a). She consulted the registered member lists of the South African Society of Hand Surgeons and Therapists, accessible to the public and thus in the public domain. The researcher sought, through purposive sampling, international experts in previous peer-reviewed publications on hand injury management. The inclusion of international experts in the eDelphi provided a comprehensive panel, incorporating best practices in clinical settings, thus allowing generalisation of the guideline. It ensured that the clinical hand rehabilitation guideline was on par with the latest clinical hand rehabilitation management strategies, nationally and internationally. Table 1 presents the inclusion criteria, where experts had to meet at least one criterion before being included in the study.

Based on a study conducted to develop a tool/guide to retrain functional tasks in hand therapy (Ohno et al., 2017), a minimum of 8–12 experts was deemed an adequate sample size for the eDelphi method. Taking into account possible attrition and Sturma et al.'s (2022) upper limb study, 15 experts were included for participation in Round 1. After Round 1, one participant did not respond to the Round 2 invitation after reminders. Fourteen experts participated in all three eDelphi method rounds.

EDelphi questionnaire design

The researcher used Research Electronic Data Capture (REDCap) software to develop the questionnaire. REDCap is a secure, web-based software platform designed to support data capturing for research studies. A questionnaire template was created on REDCap with which the experts indicated their agreement on a five-point Likert scale: 1 – strongly disagreed, 2 – disagree, 3 – neutral, 4 – agree and 5 – strongly agree. An agreement was sought for all the clinical hand rehabilitation guideline recommendations. When the experts indicated that they strongly disagreed or were neutral, branching logic in REDCap displayed an open-ended box where the experts could elaborate on why they did not agree and on what they proposed should be included in the guideline. Consensus was reached per recommendation when 75% or more experts selected, 4 – agree, or 5 – strongly agree and ‘yes’.

Questions

Fifty-five questions, originating from the previously mentioned clinical hand rehabilitation guideline stemming from the systematic reviews and FSR testing, were designed according to themes to determine a consensus regarding the physiological timeframe for commencing the exercises, passive stretching, strengthening, rehabilitation exercises, splints used, splinting timeframes, timelines when patients are advised to return to ADLs, and advice regarding the content of the light, medium, heavy and normal pre-injury ADLs. Should the experts had advised patients regarding return to light, medium, heavy and normal pre-injured tasks and functions, they were required to indicate what advice they provided to individuals under each task section and when the individual should commence the light, medium, heavy and return-to-normal pre-injury tasks and functions.

Pilot

A pilot testing preceded the main eDelphi study to determine the feasibility of the study and streamlined the procedures and technical aspects of the REDCap questionnaire. Two participants, who met the inclusion criteria as experts, were recruited by downloading the registered lists of the South

African Society of Hand Therapists and Surgeons on the internet and randomly identifying one surgeon and one hand therapist. Informed consent via an email preceded the pilot testing. Following the link on the REDCap questionnaire and selecting ‘True’ to the first question in the questionnaire implied consent. One technical error was identified during the pilot testing, which was corrected, and no changes were made to the procedures. The pilot testing results were subsequently included in the main eDelphi results.

Procedures

The layered recruitment eliminated recruitment bias. The solicitation of the nomination of field experts is considered best practice (Ludwig, 1994). After the pilot testing, the identification of experts followed. A formal invitation with information regarding the study was extended to the selected experts via anonymous emails from the researcher. The identified experts were asked to identify other experts for potential inclusion. The new experts were screened against the inclusion criteria, contacted and invited by the primary author to ensure a balance of occupations within the expert panel.

Following the identification process, information regarding the aim and procedures of the eDelphi, including a consent section, were sent in individual emails by the researcher to maintain anonymity among the participants. To ensure confidentiality, the same procedure was followed for all correspondence between the researcher and the experts. Once the experts had completed the questionnaire, they were asked to email their names and surnames to the researcher to ensure that the researcher could provide feedback following each eDelphi round and to send reminders. As described previously, the eDelphi method was conducted in rounds using REDCap software. Technical support services were available through the REDCap Help Centre, and information about how to access support services was communicated to the participants.

The expert participants who had requested a copy of the clinical hand rehabilitation guideline for reference purposes while completing the REDCap questionnaire received an email containing a copy of the guideline. Information on withdrawal procedures was included in the initial information. Experts not responding to the first, second and, if required, third eDelphi rounds after 7 days but whose questionnaire indicated an interest in participating received two reminder emails with questionnaire links. If there was no response to the reminders, the researcher viewed the lack of response as non-interest. The experts had 2 weeks to complete the questionnaire (Hsu, 2007), allowing the researcher time to analyse the results and forward the summary of findings to the experts. The researcher sent a 1-week reminder to the panel prior to each round of the eDelphi to encourage participation. The researcher exported the Likert scale responses, ‘yes/no’ and open-ended answers for data analysis from

Table 2. Demographic details of the participating experts (n = 14).

Gender (n)		Age (years)		Occupation (n)		Experience (total years)	Country (n)	
Female	9	Average	47	Occupational Therapist	5	28 (mode* = 7) (mean** = 5.6)	Australia	1
Male	5	Minimum	33	Orthopaedic Surgeon	5	29 (mode* = 7) (mean** = 5.8)	South Africa	3
		Maximum	56	Physiotherapist	4	27 (mode* = 7) (mean** = 6.8)	Switzerland	2
							United Kingdom	7
							United States of America	1

*Mode indicates the years of experience that occur most frequently.

**Mean indicates the average years of experience.

REDCap and saved the data on a password-protected laptop. The REDCap questions where consensus was reached were removed by the researcher from the next round of eDelphi, while those where no consensus was reached were included in the following eDelphi round with open-ended expert suggestions.

The open-ended responses were collated after each round, according to the fracture type and/or location, and shared with all experts in the feedback document. The researcher then updated the next rounds' statements with open-ended responses where two or more similar suggestions and clinical reasoning from experts were identified in the open-ended responses. In the instance where one expert had an open-ended response, it was documented and kept for future rounds to see if a similar response was shared, which would then be included in the expert feedback in the following eDelphi method round or final expert feedback. The open-ended responses were highly valuable since they incorporated the clinician's reasoning in developing the guideline. In instances where no additional changes were made, the stability of the expert responses was confirmed, thus indicating the end of the eDelphi method.

Following the final round of the eDelphi method, the clinical hand rehabilitation guideline was shared with the experts for a final review, after which it was finalised by the researcher.

Data analysis

The researcher calculated median, mode, minimum and maximum scores per item, and a summary of the guideline statements and percentages after each of the three rounds was sent to the expert panel.

Results

Fifteen participants agreed to participate and completed the first round of the eDelphi method. One expert did not respond to the request and reminders for Round 2, thus, 14 experts

completed all 3 Delphi rounds. The 14 experts included 5 OTs, 4 PTs and 5 orthopaedic surgeons, who were, as far as possible, equally distributed on the national (21%) and international (79%) levels. The demographics of the participants are included in Table 2. Among the experts, 236 publications, 1 book and 9 chapters related to hand injuries and management have been published, with a total of 84 years of experience.

Round 1

With the consensus percentage set at 75%, after completing the Round 1 REDCap questionnaire (Supplemental File 1), experts agreed with 28.5% of the clinical hand rehabilitation guideline recommendations. Subsequently, the agreed-upon components were removed from the REDCap questionnaire, and the remaining components were adapted to the feedback responses received from the experts during Round 1. The REDCap questionnaire expert feedback and consensus results are presented in Supplemental File 2. The feedback received included statements regarding the types of splints used after second to fifth metacarpal shaft fractures. A question was raised: 'Do we talk about conservatively treated metacarpophalangeal fractures or operated ones? Because our rehabilitation regimens differ between them?' (Participant 4)

Following Round 1, the researcher removed the statements where consensus was reached, added a wider variety of splinting options for each fracture type, separated the rehabilitation phases for surgical and conservative management, and introduced 'yes' and 'no' questions.

Round 2

Following the second round REDCap questionnaire (Supplemental File 3) completion, consensus was reached on six (18%) clinical guideline recommendations. Agreed-upon aspects included the types of light and medium functional activities, the time period of 6 weeks for the commencement of passive stretching after conservative management, the

Table 3. Grasps: Free active, no resistance allowed after injury.

Phase 1 Grasps requiring no or very little metacarpophalangeal joint (MCPJ) flexion	Phase 2 Grasps requiring minimal to 45° MCPJ flexion	Phase 3 Grasps requiring more than 45° MCPJ flexion	Phase 4 All Grasps with resistance
5. Light Tool 8. Prismatic 2 Fingers 10. Power Disk 12. Precision Disk 15. Fixed Hook 16. Lateral 17. Index Finger Extension (For index finger #) 18. Extension Type 23. Adduction Grip 26. Sphere 4 Fingers 28. Sphere 3 Fingers 32. Ventral (For index finger #) 33. Inferior Pincher Respect pain < 3/10.	1. Large Diameter 3. Medium Wrap 4. Adducted Thumb 6. Prismatic 4 Fingers 7. Prismatic 3 Fingers 9. Palmar Pinch 14. Tripod 21. Tripod variation 24. Tip Pinch 31. Ring Index finger #	2. Small Diameter 11. Power Sphere 13. Precision Sphere 17. Index Finger Extension (For middle-, ring- and little finger #) 19. Distal 20. Writing Tripod 22. Parallel Extension 25. Lateral Tripod 27. Quadpod 29. Stick 30. Palmar 32. Ventral (For middle-, ring- and little finger #)	All Grasps if no pain is present. If pain persists, consult your medical doctor.

splinting time period for shaft fractures and the splint and splinting time period used for the necks of the second to fourth metacarpal fractures after conservative management. The researcher sent the feedback to all participating experts following Round 2. In Supplemental File 2, the consensus results and expert feedback are presented.

After Round 2, the researcher removed the statements where consensus had been reached with the following changes to the third round questionnaire: Questions and recommendations, with open-ended responses, about the overarching principles of the clinical guideline; K-wire (percutaneous) and open reduction internal fixation (ORIF) with plate/stable fixation management were more clearly differentiated; and ‘yes’ and ‘no’ questions were added to the Likert scale, allowing participants to provide their opinions in open-ended responses. Finally, feedback from the experts received in the second eDelphi round was included in the following round.

Round 3

Subsequent to the Round Three REDCap questionnaire (Supplemental File 4) completion, consensus was reached on 16 (36%) guideline recommendations as follows: seven statements regarding rehabilitation, four regarding grasp exercises, one regarding base of metacarpal fractures managed with stable ORIF, one regarding the neck of the fifth metacarpal fracture managed with stable ORIF, two regarding the necks of the second to fourth metacarpal fractures managed with stable ORIF and one regarding the neck of the second to fourth metacarpal fracture managed with conservative or K-wire fixation. After Round 3, expert feedback and consensus results were sent to all experts (Supplemental File 2). The researcher shared the final clinical hand rehabilitation guideline with the participating experts for a concluding review.

Two experts provided final feedback: one responded with ‘well done’ and another made a suggestion to include Table 3 below, with the clinical hand rehabilitation guideline, as the expert found it most helpful. The participant also requested that the information be presented at a national congress. The other experts agreed with the final clinical hand rehabilitation guideline (Supplemental File 6). The content of Table 3 was informed by the aforementioned FSR study.

The experts did not forward any additional comments related to the clinical hand rehabilitation guideline to the researcher, and the guideline was subsequently accepted and finalised.

Discussion

The study aimed to develop and finalise, through expert consensus, a clinical hand rehabilitation guideline for individuals who sustained second to fifth metacarpal fractures. Thirty-two guideline recommendations informing clinical practice were included in the final clinical hand rehabilitation guideline, based on three themes: splinting and immobilisation timelines, timelines of returning to and categories of ADLs and incorporating grasp types into treatments.

Incorporating grasps in the clinical guideline is deemed imperative in rehabilitation since grasps optimise hand function and participation towards occupational performance. According to the Conceptual Model of Occupational Performance that was adapted from the OTIPM (Fisher, 2009), performance engagement in the smallest, observable task unit with performance of tasks in occupational areas is critical to occupational performance. So too are task demands, body functions and person factors as well as the demands of the environment (Fisher and Jones, 2017). Consensus about hand grasps incorporated in the clinical hand rehabilitation guideline, as the smallest task unit is consistent with the OTIPM. Kimmerle et al. (2003), who

investigated the functional repertoire hand model, urged all therapists working with individuals who had injured their hands to incorporate hand grasps in their assessment and treatment of hand injuries.

Optimal hand functioning and return to everyday tasks require being able to perform light, medium and heavy activities. These ADLs are objectively relevant to the clinical guideline and were therefore included to ensure graded returns. Agreement on the timelines to start the ADLs was also reached. Despite the recommendations made, the timeline needs to be clinically tailored to individuals, depending on comorbidities affecting fracture healing, the type of fracture and whether conservative K-wire management or surgical intervention was used to manage the fracture. The individualisation of intervention, client empowerment, respect for autonomy, a holistic perspective and a collaborative approach are key principles of the OTIPM, which the developed clinical rehabilitation guideline recognises.

Considering the immobilisation of the affected joint, the experts agreed that the MCPJ position in the splint, the splint types and the period in the splint should be guided by clinical reasoning. Toemen and Midgley (2010) echoed that the management of individuals sustaining metacarpal fractures varies, and this was also evident in the eDelphi expert responses. The experts, however, agreed that 'after metacarpal head fractures, the MCPJ position depends on the fracture pattern and position of stability', 'splint types should be clinically reasoned and individualised for each patient' and 'the splint time period should be clinically reasoned according to the fracture pattern and individualised for each patient'. However, clinical guidelines, backed by best evidence, to guide the individual's rehabilitation after having sustained second to fifth metacarpal fractures, with the potential of a delayed return to work and everyday functioning, are missing. Hence, the motivation for this research.

Kaynak et al. (2019), in a comparison of two types of immobilisation (ulnar gutter splint and a functional metacarpal hand-based splint), concluded that for the conservative management of stable Boxer's fractures, a functional metacarpal splint for 4 weeks prevents loss of reduction with improved clinical hand function, as measured with the Quick Disability of the Arm, Shoulder and Hand (QuickDASH) questionnaire and improved normal grip strength (Kaynak et al., 2019). Over the long term, however, the ulnar gutter splint and functional metacarpal splint participants presented with similar outcomes. Kaynak et al. (2019) concluded that compliance and comfort should be considered during decision-making regarding splint choices. Less joint restriction and greater compliance seem to be promoted by the functional hand-based metacarpal splint.

Van Aaken et al. (2016), in their randomised control trial (RCT), suggested a soft wrap bandage and buddy strapping for 3 weeks, with early mobilisation. This was sufficient, with good outcomes for hand function, as measured with the

QuickDASH and pain level on the Visual Analogue Scale (Van Aaken et al., 2016), and also, an open comment by a participant, who agreed: 'Splint for protection: +/- buddy tape' (M:54). In the eDelphi method applied in this research study, splinting for the conservative management of Boxer's fractures elicited responses from two participants: 'Splintage is just for comfort as the fracture is unlikely to displace. I do prefer a volar splint, though – the head is usually a displaced volar. Often, extensor lag is a problem with these fractures. Therefore, a volar splint allows early active extension'; and 'A splint is not always required. A padded bandage may be sufficient'. Other participants stated: 'Yes, sometimes, but I prefer to provide a splint for protection. If they don't wear it, fine'. (Participant 12). Another participant preferred more protection after conservative management for a Boxer's fracture and stated, '[I] would immobilise with [a] rigid splint, and limited active exercise'. (Participant 5). No consensus could be reached regarding the type of splint used after conservative management of the neck of the fifth metacarpal fracture. Subsequently, the type of splint was adapted according to the open-ended feedback and added to the next eDelphi rounds. After the third round, the participants agreed with the statement that for the conservative management of a Boxer's fracture, 'a neck of the fifth (Boxer's) fracture is generally impacted and therefore stable. Splinting is just for comfort as the fractures are unlikely to displace'. These comments were subsequently included in the clinical guidelines. Not immobilising with a splint on account of the inherent stability of the neck of the fifth metacarpal fracture is, in fact, consistent with the available literature (Kollitz et al., 2014).

Owing to a loss in rotational alignment, angulation exceeding 10° in the index and middle fingers and greater than 30°–40° in the ring and *digiti minimi*, all follow on early active mobilisation, metacarpal shaft fractures are managed surgically with locking plates (Kollitz et al., 2014). The experts agreed with the early mobilisation, as Van Aaken et al. (2016) and Kollitz et al. (2014) suggested. Consensus was reached that after stable or rigid ORIF has been used for the neck and shaft of the second to fifth metacarpal fractures, immediate early motion should be commenced to prevent the formation of adhesions. It was agreed that the time frame for commencing early active mobilisation should be 2–3 days post-surgery.

For the conservative management of neck and head of second and fourth metacarpal fractures, consensus was reached regarding the type of splint to be used. A hand-based dorsal gutter splint requires that the affected and adjacent finger MCPJ is positioned in 70° flexion but that none of the interphalangeal joints and unaffected MCPJ's should be included in the splint so that they can move freely. The benefit of the splint is backed by literature (Midgley and Toemen, 2011). The period for wearing the above-mentioned splint for 4 weeks, with continued splinting at night and over a

further period of 2 weeks of protection, and for it finally to be discarded at 6 weeks, is consistent with the literature (Midgley and Toemen, 2011). Similar to the findings of Toemen and Midgley (2010), consensus was reached for the time period of 4 weeks for neck of second to fourth metacarpal fractures managed surgically with percutaneous K-wires. In conservative management, a volar forearm base splint was the agreed-upon splint for base of second to fifth metacarpal fractures for 4 weeks. In contrast, Gülke et al. (2018) advocated a dorsal forearm-based splint.

When considering the expert agreement and consensus, the number of guideline recommendations over the three eDelphi rounds indicating consensus, a smaller number of guideline statements were accepted. It could be hypothesised that as the experts completed the rounds, they also offered comments and suggestions which were related to clinical reasoning and based on their experience. The experts thus provided their clinical expertise in the open-ended responses. These clinician responses were presented to the other experts in the following rounds. Hence, the iterative process, where clinician experiences were identified from the open-ended response and included in the following Delphi rounds, was imperative and highly informative. It was difficult to predict from the outset of each eDelphi round the number of recommendations that would be accepted at the end of the round due to the iterative process during the eDelphi method. The time between eDelphi rounds and the sharing of open-ended responses with all experts may also have given them time to reflect on their and others' management preferences and reasoning. It is hypothesised that reflection by the experts between rounds when reading the open-ended responses of fellow experts may have impacted the subsequent eDelphi rounds.

A limitation of the eDelphi method was not calculating the expert knowledge coefficient (kc), the argumentation coefficient (ka) or the expert competence coefficient (K) before inclusion of the experts. The inclusion of experts from one low-income country, compared to four high-income countries, and including predominantly participants from the United Kingdom may have skewed the sample, which with a larger sample size may have been negated.

Additional limitations encompass the potential for expert fatigue and doubts regarding the credibility and trustworthiness of the research. When embarking on any research endeavour, it is incumbent upon researchers to address concerns surrounding the dependability and validity of their methods. Dependability pertains to the consistency of outcomes when a procedure is employed under consistent circumstances. In the context of the eDelphi method, there is an absence of empirical support regarding its dependability. In other words, it remains uncertain whether presenting identical information to two or more groups would yield congruent results.

To address this challenge, one can employ Lincoln and Guba's (1985) criteria tailored for qualitative studies. These criteria encompass four key facets: credibility (concerning truthfulness), fittingness (pertaining to applicability), auditability (focusing on consistency) and confirmability. The eDelphi method operates on the premise that collective decision-making involving multiple individuals is less prone to erroneous conclusions than individual decision-making. Decisions are further fortified through reasoned discourse that challenges underlying assumptions, thereby bolstering the method's validity.

However, threats to validity primarily stem from the pressure for consensus in predictions, as noted by Hill and Fowles (1975), which can undermine the eDelphi's predictive capabilities. Nevertheless, employing participants possessing specialised knowledge and a vested interest in the subject matter may enhance the content validity of the Delphi method, as advocated by Goodman (1987). Additionally, employing successive rounds of questionnaires can augment concurrent validity.

Nonetheless, it must be acknowledged that the validity of the research findings ultimately hinges on response rates. Due to stringent timelines, the researcher was unable to solicit input from an external board of stakeholders in the final guideline evaluation process.

The eDelphi method's strengths in this research's context included anonymity, whereby each expert was allowed to express his/her views openly in the open-ended responses in the REDCap questionnaire. Anonymity also ensured that a dominant participant did not overpower the conversation or pressurise the participants to confirm. Including expert PTs, OTs and orthopaedic surgeons specialising in hand injuries strengthened the consensus findings and, as such, the eDelphi development of the guideline. The primary author considered the Conducting and Reporting of eDelphi Studies (CREDES) recommendations in the planning and execution of this eDelphi method (Jünger et al., 2017). To strengthen the reliability and validity of the eDelphi method, the researcher utilised the CREDES recommendation table to indicate how this research study adhered to CREDES reporting recommendations (Supplemental File 5).

Conclusion

With the eDelphi method, experts in the field of hand injury management participated in an iterative three-round questionnaire to refine, develop and finalise recommendations in a clinical guideline for each type of second to fifth metacarpal fracture without any involvement of soft-tissue, vascular or neural components. Collating expert consultation systematically, with clearly defined consensus and methods, adheres to CREDES rationale, planning and design, and study conduct recommendations. The 32

guideline recommendations stemming from the eDelphi method, backed by clinical reasoning for the unique individual patient presentation, may be used internationally, but more pertinently in lower and middle-income countries with a lack of resources, as a blueprint, in second to fifth metacarpal fracture rehabilitation, and a starting point of future high-quality RCT's to ensure best practices for shaft, head and base of metacarpal fractures.

Key findings

- Incorporating hand grasp types in rehabilitation is essential to enhance hand functionality.
- Following conservative or K-wire management, implementing specific grasp types in the rehabilitation programmes for metacarpal fractures can significantly enhance hand function.
- Implementing grasp types in hand rehabilitation for the affected MCPJ, specifically second to fifth metacarpal fractures treated with stable ORIF, can commence within 2–3 days after the procedure.
- Although expert consensus was reached about splinting and immobilisation types and timelines, which may be valuable for clinical practice, they concluded that splint selection should be based on clinical assessment and tailored to meet each patient's specific needs.
- Return to light ADLs within 2 weeks, medium ADLs within 4 weeks, heavy ADLs within 6 weeks and a return to pre-injury tasks, activities, and functions can typically occur within 8–10 weeks post-injury.
- The timeline for commencing ADLs should be customised to the individual, considering comorbidities, fracture type and management.
- The OTIPM should form the basis of using the developed clinical hand rehabilitation guidelines.

What the study has added

The study contributes to the implementation of hand rehabilitation recommendations of splinting and immobilisation timelines, incorporation of grasp exercises to allow for the attainment of hand function, and education of return to ADLs for OTs and PTs, general practitioners, emergency care and orthopaedic surgeons, who manage individuals after sustaining second to fifth metacarpal fractures.

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Research ethics

This research has been approved by the HSREC of the University of the Free State under the number (UFS-HSD2019/0046/2602-0003) obtained in 2021.

Consent

Participant provided informed consent on the REDCap system by selecting and clicking 'True' before proceeding to complete the first round questionnaire.

Patient and public involvement data

During the development, progress and reporting of the submitted research, Patients and Public Involvement in the research was included in the conduct of the research.

Declaration of conflicting interests

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Contributorship

MK proposed the topic for the research, wrote the protocol for ethical approval and the first version of the article. The protocol and article were read, elaborated upon and refined by MK, RB and CB.

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Supplemental material

Supplemental material for this article is available online.

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