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Literature review

Splints, with or without wrist immobilization, following surgical repair of flexor tendon lesions of the hand: A systematic review



Orthèses, avec ou sans immobilisation du poignet, après réparation chirurgicale de lésions des tendons fléchisseurs de la main : revue systématique

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ABSTRACT

Splints with or without wrist immobilization can be used during the rehabilitation of flexor tendon lesions of the hand. The evidence base for these techniques has not previously been studied in a systematic review. We sought to thoroughly review patient-reported functional outcomes and pain to compare splinting with or without wrist immobilization. Five bibliographic databases were searched. Studies were considered for inclusion if they were randomized controlled trials or observational comparative studies reporting the difference in outcome among patients treated with or without wrist immobilization. No limits were set on publication date or language. Study selection was performed independently by two authors, and disagreements were resolved by consensus. The review protocol was preregistered in PROSPERO. There were no randomized controlled trials. No studies could be included based on our inclusion criteria. We decided to qualitatively summarize the most relevant studies although they did not meet our inclusion criteria. This resulted in a narrative review of the studies we found relevant. Based on the current literature, it is impossible to provide evidence-based recommendations for or against wrist immobilization during the rehabilitation period following flexor tendon repair. The lack of high-quality evidence points to a need for randomized clinical trials to guide rehabilitation decisions.

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R É S U M É

Les orthèses avec ou sans immobilisation du poignet peuvent être utilisées dans la rééducation des lésions des tendons fléchisseurs de la main. Les données probantes concernant ces techniques n'ont pas fait l'objet d'un examen systématique. Notre objectif était d'examiner méthodiquement les résultats fonctionnels et la douleur rapportés par les patients en comparant les orthèses avec ou sans immobilisation du poignet. Cinq bases de données bibliographiques ont été investiguées. Les études ont été utilisées si elles étaient des essais comparatifs randomisés ou des études comparatives observationnelles ayant rapporté les différences dans les résultats observés chez les patients traités avec ou sans immobilisation du poignet. Aucune limite n'avait été fixée sur la date de publication ou la langue. La sélection des études a été réalisée indépendamment par deux auteurs et les controverses ont été résolues par consensus. Le protocole de révision a été préalablement inscrit à PROSPERO. Nous n'avons trouvé aucun essai contrôlé randomisé. Aucune étude ne répondait à nos critères d'inclusion. Nous avons décidé de réaliser une synthèse qualitative des études les plus pertinentes, bien qu'elles n'aient pas répondu à nos critères d'inclusion. Il en est résulté une revue descriptive des études jugées les plus pertinentes, même si elles ne répondaient pas à nos critères d'inclusion prédéfinis. Sur la base de la littérature actuelle, il n'est pas possible de formuler des recommandations fondées sur des preuves pour ou contre l'immobilisation du poignet pendant la période de rééducation suivant la réparation des lésions des tendons fléchisseurs. L'absence de preuves de qualité plaide pour la conduite d'essais cliniques randomisés pour guider la rééducation.

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1. Introduction

Rehabilitation after surgical repair of flexor tendon injuries of the hand is a central part of treatment. The rehabilitation must strike a balance between early mobilization to sustain function and immobilization to protect the surgical repair. These injuries are relatively rare, with an incidence of 14 flexor tendon injuries per 100,000 inhabitants per year [1]. However, due to the patient's potentially long-term disability, the postoperative treatment is important. Functional disability can result from excessive postoperative immobilization causing adhesion formation, poor tendon gliding, and joint stiffness [2]. Several postoperative mobilization protocols exist, including immobilization, early passive mobilization, and early active mobilization [2]. Thus, there are several ways of applying controlled stress to the healing tendon. Applying early postoperative stress to the tendon intensifies the healing process at the repair site. This results in higher tensile strength as well as better excursion and less adhesion formation [3,4].

One of the first contributions regarding early mobilization was made by Kleinert et al. [5] who introduced a dynamic splint, fixing the wrist in a flexed position with rubber bands, which allowed early mobilization with passive flexion and active extension. It was previously believed that a minimum amount of tension would be applied on the healing tendon when placing the wrist in a moderate flexed position. This position was subsequently used by many surgical teams [6]. Later on, there was a shift towards a more extended position, as this position places less tension on the healing tendon [7].

Some authors argue that rehabilitation should enable motion of the distal interphalangeal (DIP) joint since the motion creates differential gliding of the flexor digitorum profundus (FDP) and the flexor digitorum superficialis (FDS). Slattery and McGrouther [8] developed a splint that allowed this motion during tendon healing in contrast to Kleinert's method which only facilitates motion of the metacarpophalangeal (MCP) joint and the proximal interphalangeal (PIP) joint [5]. Though motion is important, it is just as important not to apply more stress to the tendon than it can sustain, since too much loading can result in rupture. When measuring tendon tension, it has been shown that "synergistic wrist motion", which refers to a motion where the fingers are fully extended when the wrist is flexed, and the fingers are fully flexed when the wrist is extended, places minimal tension in the tendon during a full fist with a wrist extension [9]. Furthermore, tendon excursion is increased when using synergistic wrist motion compared to an immobilized wrist [10].

The differences between passive flexion and active extension protocols, controlled passive motion protocols, combined "controlled passive motion" and "passive flexion and active extension" protocols, and early active motion protocols were evaluated in a systematic review [11]. Chesney et al. reported that early active mobilization protocols resulted in more excellent or good outcomes, based on the Strickland and Glogovac classification [12], compared to early passive mobilization protocols [11]. Another systematic review reported a decreased risk of rupture with passive mobilization protocols, but also less range of motion compared to active mobilization protocols [2]. Though a number of studies have investigated the effectiveness of these different regimens [2,11–13], the evidence base for the different splinting options has not previously been studied in a systematic way. While some have suggested the optimal splint position for postoperative mobilization is an extended wrist and flexed MCP joints [7], the difference in functional outcomes between this type of long splint and a shorter splint that does not immobilize the wrist has not been elucidated (Fig. 1).



Fig. 1. Splint that does not immobilize the wrist.

The aim of our study was to systematically review patient-reported functional outcomes and pain when comparing splints with or without wrist immobilization. Secondary aims were to report on health professional-reported functional outcome.

2. Material and methods

This review used the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines for reporting [14]. The review protocol was registered in the international prospective register of systematic reviews (PROSPERO) database (registration number: CRD42018092517) prior to study selection.

2.1. Eligibility criteria

Studies were considered for inclusion if they were randomized controlled trials or observational comparative studies reporting the difference in outcomes between patients treated with or without wrist immobilization. Studies involving adults over the age of 18 who underwent surgical repair after flexor tendon lesion of the hand were considered for inclusion. No limits were set on publication date or language. We excluded animal studies and studies involving patients who underwent tenolysis surgery, or who also had a nerve injury. There were no limits on the choice of active or passive mobilization protocols.

2.2. Search strategy

We searched the PubMed, Embase, Web of Science, CINAHL and Cochrane Library databases to identify relevant studies; a modified search strategy was developed for databases not using MeSH terms. The keywords used for each of the databases were the followings: “flexor tendon”, “splints” [MeSH], “Kleinert”, “exercise therapy” [MeSH], “rehabilitation” [MeSH]. The search was conducted by two investigators between March 28th and April 2nd 2018. The reference lists of relevant studies were reviewed to identify additional relevant studies. A citation analysis of all included studies was conducted in Scopus.

2.3. Study selection

The initial retrieval of eligible references based on title and abstract was performed by one author. All references clearly not relevant to the review question were excluded (Fig. 2). Studies with insufficient information in the title and abstract to make the decision for eligibility were read in full text. Full text assessment for inclusion of the screened articles was conducted by two authors independently. Disagreement regarding inclusion was resolved by consensus. Interventions of interest included orthosis treatment comparing splints with or without wrist immobilization following surgical repair of flexor tendon lesions of the hand. The primary variable from the included studies was patient-reported functional outcomes and pain with health professional-reported functional outcomes as secondary. Any complications were documented.

2.4. Data collection process

Data extraction was conducted by two authors independently using pre-tested forms.

2.5. Risk of bias in individual studies

Two authors assess the risk of bias independently using the Cochrane risk of bias tool for randomized trials [15].

2.6. Summary of findings

The aim was to summarize data from included studies. But since no suitable studies were included in the final analysis, a qualitative summary was structured around types of splints and functional outcomes based on relevant studies that did not meet the formal inclusion criteria.

3. Results

3.1. Study selection

The initial search generated 2270 articles (Fig. 2). One hundred and fifty-four studies were considered eligible for inclusion based on title and abstract. A full text screening was conducted by two authors independently. Of the 1643 studies screened, two studies were unavailable. Of the 154 identified articles assessed in full text, three studies were unavailable. Two studies pertaining to additional nerve injury were excluded [16,17]. One comparative study was excluded due to inclusion of patients treated non-surgically [18]. One comparative study was excluded since it had no well-defined outcome measures [19]. There were no randomized controlled trials. No studies could be included in our systematic review based on our inclusion criteria. A meta-analysis was not feasible due to the absence of comparative studies that met our inclusion criteria. We decided to provide a brief summary of the most relevant studies to gain insight on the current state of knowledge on this topic [17,19,20].

3.2. Results of individual studies

We only found a very small number of relevant studies. The comparative studies we found were either pilot studies [19] or studies that included patients with additional nerve injury [16,17]. One study did not clearly state that all the patients had undergone surgical repair [18]. The authors of that study were contacted for further information, but without success.

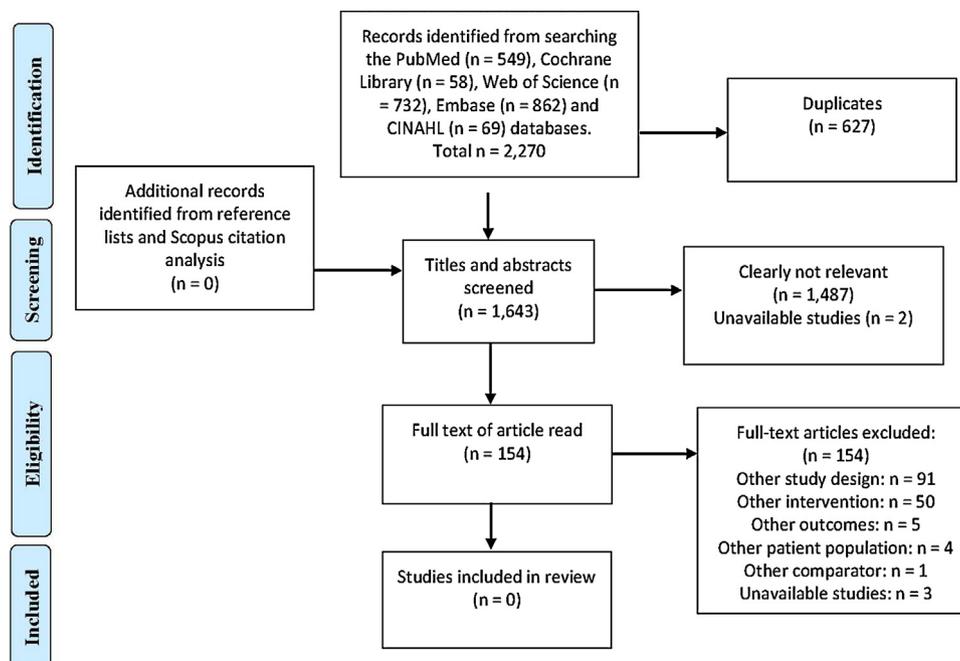


Fig. 2. Flowchart summarizing the study selection process.

3.3. Summary of studies not eligible for inclusion

3.3.1. Synergistic wrist motion versus static wrist

A prospective comparative study investigated which protocol would improve patient outcomes by comparing the Modified Belfast protocol, consisting of early active exercises with an immobilized wrist, to synergistic wrist motion [19]. Group allocation was determined by accessibility of the patient and therapist. The authors reported that patients treated with a splint allowing synergistic wrist motion achieved better functional outcomes than those treated with a splint that held the wrist static [19]. Although the study found better functional outcomes in the synergistic wrist motion group, the results are potentially biased due to the fact the synergistic wrist motion group received rehabilitation from one clinical specialist whereas the static wrist group received rehabilitation from various therapists with different skill levels. The study had no description of the severity of the lesions and no description of patient compliance and motivation. The patients allocated to the synergistic wrist motion group may have wanted to be allocated to this particular group and may have been more motivated relative to the patients in the Modified Belfast group [19].

3.3.2. Splinting with or without wrist immobilization

A retrospective comparative study with a historical control compared two types of splint treatment following surgical repair of zone II flexor tendon lesions [17]. The protocol consisted of passive flexion exercises and active motion. A traditional forearm-based dorsal blocking splint immobilizing the wrist in a neutral position with the MCP joints flexed 30 degrees was compared with the Manchester short splint, which extends from

the proximal wrist crease to the fingertips and leaves the wrist free to move up to 45 degrees extension and full wrist flexion, while blocking the MCP joints in 30 degrees flexion. Peck et al. [17] developed this shorter version of the traditional forearm-based dorsal splint to allow more wrist motion to promote tendon gliding and interphalangeal joint motion, with the goal of achieving a better functional outcome. Results of PIP extension deficit at 12 weeks' follow-up are presented in Table 1. Total range of motion did not differ significantly between the two groups after 12 weeks. Based on the Strickland classification, the Manchester short splint group had 22% excellent outcomes compared to the traditional forearm-based splint, which had only 6% excellent outcomes [17]. Selection bias is a potential risk in this study as only patients with high compliance were fitted with the Manchester short splint. The fact that patients in this group had a clear understanding of their injury and understood the importance of attending rehabilitation sessions may have biased the results. This group also received more supervision than the group with the long splint; this may also have been a source of bias and the use of a historical cohort may have influenced the results. Finally, the Manchester short splint does not allow free wrist motion, as the splint is designed to have an extension stop at 45° extension. Thus, this study only partially contributes to answering our review question. In order to show a clinically relevant effect of the Manchester short splint, a randomized controlled trial comparing splints with or without wrist immobilization is required.

3.3.3. Mobilization without splinting

One team investigated whether their suturing method could improve the results of flexor tendon lesions in a retrospective

Table 1
Characteristics of studies included in qualitative review.

Study	Age (years) Mean or range	Sex	Zone of repair	Complications	Drop-outs	Outcomes	Negative outcomes	Authors' conclusion	Funding
Horsfall [19]	16–65	NS	Zone I–IV	NS	NS	Group without wrist immobilization achieved 91% "excellent" TAM vs. 5% in the group with wrist immobilization	NS	Potential risk of bias in synergistic wrist motion group	NS
Peck et al. [17]	Group A: 34	42 males 20 females	Zone II	Single digital nerve injuries	At 12 weeks: group A (with immobilized wrist): 39%	At 12 weeks: patients in group B had reduced extension deficit in the PIP joint (median difference = 12 degrees, $P=0.024$)	Group A: 3 ruptures	Manchester short splint is safe, enhances finger flexion and facilitates IP flexion and extension	None
	Group B: 31	Group B (without immobilized wrist): 30%			Both groups showed improvement in the DIP joint flexion (median difference = 26 degrees, $P\leq 0.001$)	Group B: 2 ruptures			
Ryoke et al. [20]	33	11 males 2 females	Zone II	Nerve injuries and arterial lacerations	NS	Strickland classification: "excellent": 8 digits; "good": 5 digits; "poor": 1 digit	No ruptures	Combination of side-locking loop technique and cross-stitch peripheral epitendinous repair allows mobilization on first postoperative day	NS

TAM: total action motion; NS: not specified; IP: interphalangeal.

study [20]. The patients performed passive flexion and extension exercises the first day after surgery, without using a splint to protect the repair site. Three days postoperative, active mobilization exercises were allowed. Functional outcomes were measured on the Strickland classification system. The study found excellent outcomes in 8 out of the 14 digits in 13 patients, and the authors concluded their suturing method was effective for allowing early active motion without the use a splint [20]. There were no tendon ruptures in the study. Although the study reported excellent outcomes in the majority of the patients, the small sample size and lack of a control group weakens our ability to make any conclusions from it.

4. Discussion

This review sought to analyze the difference between treating patients with or without wrist immobilization during the rehabilitation period following surgical repair of flexor tendon lesion of the hand. We found no studies comparing splint treatment with or without wrist immobilization that met our inclusion criteria. We therefore chose to summarize selected articles by describing them as we believe these studies still provide relevant evidence. Despite the fact these studies did not meet our inclusion criteria, their main focus was still splinting with or without wrist immobilization. One study even suggested that a postoperative splint was unnecessary for rehabilitation. The lack of evidence related to our review question led us to include literature that would otherwise not have been considered.

Overall, splinting without wrist immobilization has been reported to be safe and to enhance flexion of the IP joints [17,19]. However, the results must be interpreted with caution as several potential biases are present. Despite the differences between groups discovered by Horsfall [19], a difference in rehabilitation sessions beyond the splints might have influenced the results. The conclusion might also be weakened by the small sample size and lack of randomization and blinding. Peck et al. [17] used historical cohorts, thereby making between-group differences beyond the splints a possible influencer of the results. Only patients who could attend weekly rehabilitation sessions and who were able to adhere to the protocol were chosen for the short splint. Thus, it is unclear whether it is the splint or the patients' compliance to the prescribed rehabilitation that drove the differences between groups. As potential biases may have influenced the results, it is difficult to conclude whether the splints in question had any advantages or disadvantages. As we know that tendon excursion is a crucial part of the rehabilitation [3,4], one could easily assume that a splint, which does not immobilize the wrist would further enhance tendon excursion. However, no difference in excursion was found when a splint, which uses synergistic wrist motion was compared to the Kleinert splint [21]. Still, the wrist's position has been proven to have an impact on rehabilitation. Tanaka et al. [9] stated that wrist position was important and found it to have a clear effect on tendon tension. However, no tendon tension was found during synergistic wrist motion [9]. There is no additional risk of applying a splint that does not immobilize the wrist [17]. Many rehabilitation protocols use the traditional forearm-based dorsal blocking splint, although studies have shown the beneficial effect of wrist mobilization [10]. This may be due to the evidence in this area being inadequate. This highlights the need for new studies to clarify the effect of using a short splint. Because of the lack of evidence within this field, we cannot be certain whether there is a difference between the long and short splints. Well-conducted studies would help guide the rehabilitation and clarify whether a short splint will contribute to faster functional recovery or result in secondary tendon rupture.

It is debatable whether our exclusion criteria for patients with additional nerve injury makes sense, as many patients with flexor tendon lesions inevitably have additional nerve injury. We did not search for unpublished literature. Thus, it is possible there is unpublished research elsewhere. We chose to do a qualitative summary of the evidence that did not meet our inclusion criteria to emphasize the need for further high-quality research.

5. Conclusions

We searched the literature to see if splint treatment without wrist immobilization could work as an alternative to splint treatment with wrist immobilization. We found no high-quality evidence comparing splinting with or without wrist immobilization that met our inclusion criteria. The lack of high-quality evidence has left us unable to answer our review question. We therefore chose to do a narrative review of other relevant studies identified through our search strategy. Based on the current literature, it is impossible to provide evidence-based recommendations for or against splint treatment with or without wrist immobilization during the rehabilitation period following flexor tendon repair. Well-conducted clinical trials are needed, as this will benefit the rehabilitation of these patients. The lack of high-quality evidence means that randomized clinical trials need to be performed to guide rehabilitation choices.

Disclosure of interest

The authors declare that they have no competing interest.

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