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Efficacy of orthotic devices for increased active proximal interphalangeal extension joint range of motion: A systematic review

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ABSTRACT

Study Design: Systematic review.
Introduction/Purpose of the Study: To determine the efficacy of orthotic devices for increased active proximal interphalangeal (PIP) joint range of motion and optimal wearing schedule of the devices to guide clinical practice. The secondary purpose is to capture the outcome measures used by the authors. The final purpose was to determine if recent studies addressed patient satisfaction and adherence in the orthotic management of a PIP joint injury.
Methods: A comprehensive literature search was conducted using the search terms splint, orthotic device, hand orthotic, brace, proximal interphalangeal joint, occupational therapy, and physical therapy using PubMed, CINAHL, MEDLINE, and ProQuest. The following data were extracted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines: background statement, objectives, data sources, study eligibility criteria, participants, and interventions, study appraisal and synthesis methods, results, limitations, conclusions, and implications of key findings.
Results: Best results were achieved when the PIP orthoses were worn for a longer duration especially for the treatment of extension deficits.
Discussion: Studies that provided a wearing schedule of a minimum of 6 hours obtained the greatest improvements in extension deficits of the PIP joint.
Conclusion: Recommended orthotic dosage to treat PIP joint injury is at least 6 hours a day for 8-17 weeks.

Introduction

The proximal interphalangeal (PIP) joint is the structure producing the largest range of motion (ROM) in the hand,[1] accounting for 85% of the grasping capabilities of the fingers.[2] According to Caravaggi et al,[3] the PIP joint is bicondylar, and its articular surfaces contribute to the stability in the frontal plane while permitting larger and almost unrestricted motion in the sagittal plane. Bony stability, sensibility, muscle integrity, tendon gliding, and joint flexibility are required for motion to occur in a finger.[4] Ligament injuries of the PIP joint can result in a complete tear, partial tear, or sprained ligament. Complete disruption of the PIP joint occurs when both the collateral ligaments and volar plate are torn, and this is accompanied by resection of at least 30% of volar lip of the middle phalanx, resulting in gross instability of the joint.[3] PIP joint contractures are common finger injuries seen by hand therapists and surgeons after joint dislocation, subluxation, synovitis, ligament damage, soft tissue injury, or prolonged edema of the hand.[5,6] Conversely, PIP joint injuries left untreated can manifest to substantial pain, stiffness, instability, and eventually, arthritis.[3] Many nonsurgical interventions, such as orthotic devices, restore the ROM at the PIP joint and are considered an effective method to treat PIP injuries.[6]

The reason for orthotic intervention varies but may include the following: (1) increase function, (2) prevent deformity, (3) correct deformity, (4) protect healing, (5) restrict motion, and (6) allow tissue growth and remodeling.[7] Various prefabricated orthotic intervention techniques are of low cost and designed to remodel the shortened soft tissue structures, which cause limitations.[5] The LMB spring wire (Deroyal Industries, TN), Reverse Knuckle Bender (Bunnell, CA), Joint Jack (The Joint Jack Company, CT), Capener orthosis (Lifetec Inc, IL), and the Dynasplint (Dynasplint Systems,

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Inc, MD) are prefabricated mobilizing orthotics that aid in improving PIP extension. Custom orthoses can be applied but can be time consuming to fabricate. Serial casting limits active flexion of the digit because of the full-time wearing schedule and bulk of the cast. Proper positioning of the cast is another consideration. Prefabricated orthotics and custom-made orthotics promote corrections to the contracture and are donned and doffed easily when needed.[5]

Freeland et al[8] discussed rehabilitation for proximal phalangeal fractures, including dynamic orthotics, serial finger casting, and surgical release. Early controlled stress can prevent the formation of PIP flexion contracture, and not all PIP joint injuries result in flexion contractures. To regain PIP joint motion, the authors recommended using dynamic orthotics or serial finger casting while relegating surgical procedures as a last resort when dealing with PIP joint contractures.[8] A Cochrane review[9] identified 3 studies that assessed intervention strategies for conservative management of hyperextension injuries of the PIP joint. None of the studies produced statistically significant results to determine the optimal treatment for PIP joint hyperextension injuries using a plaster cast or aluminum orthotic device.[9] The incidence of PIP flexion contractures has not been well defined. One study reported a 10% complication rate with dorsal fracture dislocations for the PIP joint.[10]

The purpose of this systematic review is to appraise the current literature to determine the efficacy of orthotic devices for increasing active PIP joint ROM and determine optimal wearing schedule of the devices to guide clinical practice. The secondary purpose of this review is to capture the outcome measures used by the authors.

Methods

Identification and selection of studies

Inclusion criteria were studies that determined the effectiveness of orthotic devices on contractures of the PIP joints, including randomized controlled trials (RCTs), quasi-experimental trials, and cohort studies published within last 10 years. Older studies were excluded from this review because we wanted to determine current practice patterns, and more recent studies are of better methodological quality. Findings were excluded if studies were published using participants younger than 12 years and not in English language. Surgical interventions and Dupuytren's contracture were also excluded from this systematic review. After article review, 6 articles were excluded based on the criteria specified previously.[11-16]

Search strategy

PubMed, CINAHL, MEDLINE, and ProQuest were the computerized databases searched (Table 1). Search terms were as follows: splint, orthotic device, hand orthotic, brace, proximal interphalangeal joint, occupational therapy, and physical therapy. Orthotics, braces, and splints are terms often used interchangeably by many health care professions. All 4 authors conducted individualized searches and collectively determined which articles were eligible for inclusion. Abstracts of pertinent articles were reviewed, and supplementary hand searches were performed to identify prospective additional studies. There was no discrepancy between the authors as to which articles would be included.

Table 1
Database search strategy

Database	Hits (no. of after limits)	Obtained	Keywords
CINAHL	16	0	proximal interphalangeal joint AND contracture AND orthoses OR splint AND range of motion NOT surgery NOT dupuytren's
MEDLINE	13	2	proximal and kw: interphalangeal and kw: joint)) and kw: contracture) and (kw: orthoses OR kw: splint
ProQuest	168	3	(proximal interphalangeal joint) AND (pip contracture) AND splint OR orthosis NOT surgery NOT Duppuytren's AND (hand therapy) AND (occupational therapy) AND (range of motion) AND (PIP flexion)
PubMed	53	0	proximal interphalangeal AND splint OR orthosis AND hand therapy OR physical therapy OR occupational therapy AND management AND orthosis OR splint NOT surgery NOT Dupuytren's NOT foot AND hand NOT stroke

Participants

The following data were extracted from the studies: subject age, number of participants included, study design, type of PIP joint injury, type of orthotic device received, and subject ROM gains (Table 2).

Interventions

The following data were extracted regarding the orthoses used in the studies: type of orthotic device, initiation of orthotic treatment after injury, dosage of application, complications, and satisfaction with the device if reported. Three of the studies[6,17,18] focused on extension contractures, and the fourth study[19] focused on preventing flexion contractures.

Outcomes

All primary and secondary outcomes used by the authors were also extracted. All outcome measures used by the authors were also extracted from the studies.

Study quality assessment

The quality of the studies selected was evaluated by 3 of the authors using the Structured Effectiveness for Quality Evaluation of Study (SEQES).[20] The SEQES was developed by MacDermid[20] and contains 24 items used to critically appraise and systematically analyze the methodological features of each study. The investigators obtained a SEQES score by totaling the scores of each item in the tool. A score of 0 for 1 item indicates that the study failed to fulfill the requirements for that specific tool. A score of 1 indicates a fair fulfillment of the requirement, whereas a score of 2 is the highest score attainable. The SEQES scores of each investigator were blinded to the other members of the group until all 4 reviewers collaborated their scores. Any disagreements about a certain score were deliberated until a consensus was reached. The minimum score needed for a study to be included in this review was 20.

Table 2
Participant information and study methods

Author	Number of subjects	Age range	Blind assessor	Study design	Outcome measures	Time since injury (wk)	Orthotic intervention	Follow-up time frame	Follow-up, %
Cantero-Téllez et al[6]	60	31-42	Yes	Single blinded RCT	PIP joint extension DASH	4-24	n = 30 night static-progressive orthoses and dynamic daily orthoses n = 30 hand therapy treatment	3 mo	95
Glasgow et al[19]	41	15-72	No	Prospective cohort study	PIP flexion/extension lag	5-31	n = 26 joints, dynamic flexion orthoses, similar design to Capener orthosis n = 22 joints, handmade Capener orthosis	16-17 wk	100
Glasgow et al[17]	22	20-72	No	RCT	PIP extension lag	7-20	n = 22 dynamic Capener orthoses	8 wk	81
Rajesh et al[18]	32	12-74	No	Prospective cohort study	PIP ROM & extension lag Belsky classification by radiographic assessment	<1	n = 32 thermoplastic MCP block orthotic devices for PIP fractures	15 mo (13-16 mo)	100

RCT = randomized controlled trial; PIP = proximal interphalangeal; DASH = Disabilities of the Shoulder, Arm and Hand; ROM = range of motion; n = number; MCP = metacarpophalangeal.

Data analysis

The effect of each outcome was determined using an effect size calculator.[21] The effect size of each intervention was calculated when enough information was provided in the study regarding the means and standard deviations of the outcome. According to Cohen's d index, the effect size was interpreted.[22] This permitted for categorization to determine treatment effectiveness. Small (0.3), medium (0.5), or large (0.8) were the interpretations used for determining the success of each treatment intervention.[22] Effect size of PIP ROM could be calculated for 2 of the included studies.[6,17] Cantero-Téllez et al[6] required additional calculations to determine the standard deviation required for effect size. The standard deviation was calculated by using a formula based on confidence intervals (CIs) and the mean.[23] The remaining 2 studies[18,19] did not have enough information provided to be calculated.

CIs were also calculated because they provide a range of scores that includes the true population mean lie within them (95%). This range indicates that the researchers are 95% confident that the scores fall within the margin of error. When 0 is not included within the CI, it is assumed that true change occurred for that population.[24] Three studies[6,18,19] had their CI calculated.

Results

Search results

The preliminary search strategy identified a total of 250 articles. After the elimination of duplicates and the scanning of titles and abstracts, a total of 10 potentially relevant studies were taken into consideration. Five articles were published more than 10 years ago, and 1 study was identified as a duplicate and removed. Each member conducted a full-text review of these 10 studies, and 4 studies met the inclusion criteria for this review. Two of the studies[6,17] were RCTs, whereas the other 2 studies[18,19] were prospective cohort studies. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram illustrates the flow of information through the different phases of the systematic review (Fig. 1).

Subjects

There were a total of 155 subjects. Subjects were between the ages of 12 and 74. There were 75 males and 19 females. Glasgow et al[19] did not mention their exact male-to-female ratio. Two study subjects[6,19] suffered a traumatic injury resulting in a contracture of the PIP joint, 1 study included subjects who had a PIP fracture of the finger,[18] and the final study[17] included subjects who had both injuries. In addition, Glasgow et al[17,19] reported that subjects had a contracture of the PIP joint with passive range of motion of that joint 80% or less than the unaffected side.

All eligible studies provided exclusion criteria. Each study excluded subjects with the presence of infection, inflammation, or previous joint injury, such as bony or tendon injury. Two studies[17,19] excluded subjects who had previously used a dynamic orthosis, acute complex regional pain syndrome, or artificial joints (Table 2).

Interventions

One study[6] evaluated the use of a custom-fabricated night static-progressive orthoses and custom-fabricated dynamic day time orthoses compared with therapy[6] (Figs. 2 and 3). Another study[19] evaluated a custom-made Capener orthosis for patients with extension deficits (Fig. 4). Another study[17] also evaluated a dynamic Capener orthosis[17] (Fig. 4). The final study[18] evaluated a

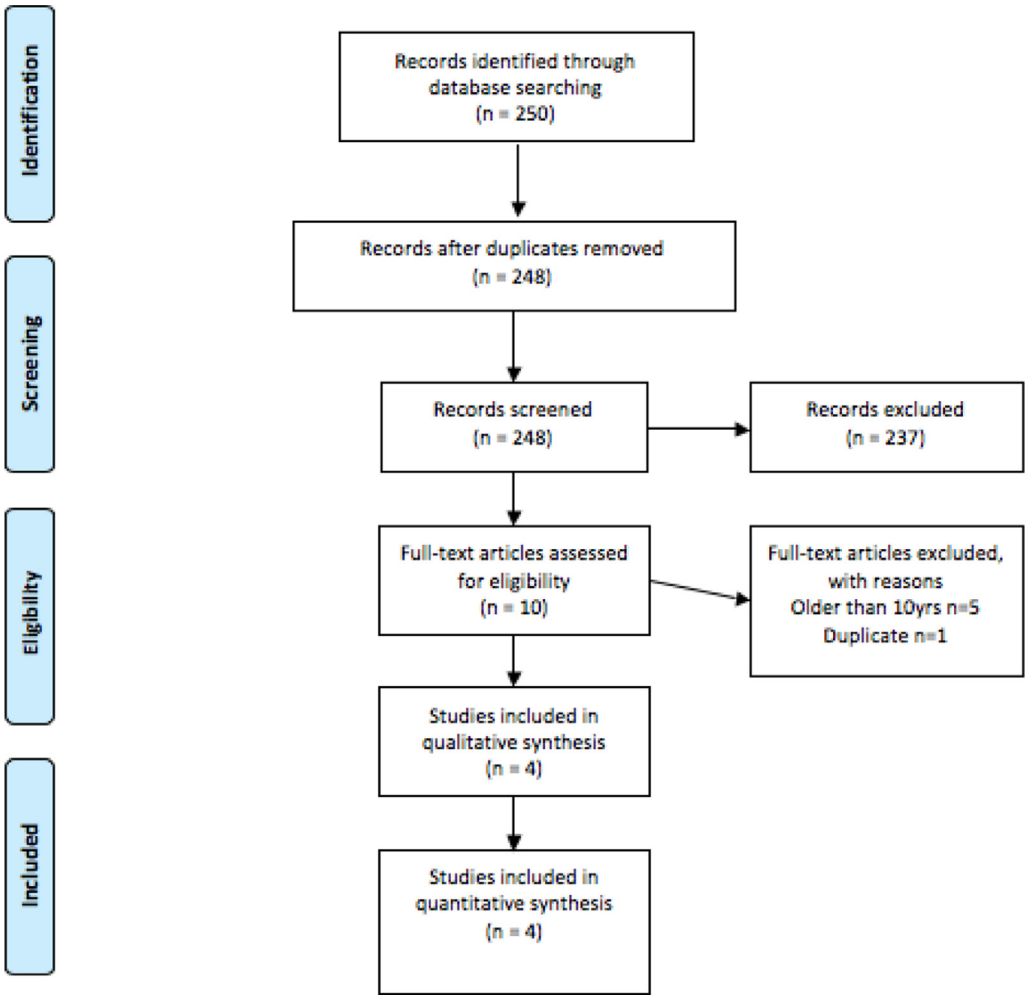

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2009 flow diagram. From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA statement. *PLoS Med.* 2009;6(7):e1000097. For more information, visit www.prisma-statement.org.

custom-fabricated thermoplastic metacarpophalangeal block orthotic device, which blocks the action of the extension digitorum communis to promote better PIP extension[18] (Figs. 5 and 6). To prevent the motion limitations, Rajesh et al[18] initiated orthosis intervention at less than 1 week.[18] Other authors initiated orthosis intervention between 4 and 31 weeks after injury.[16,17,19]

Three authors[6,17,19] advised their subjects to wear the orthoses for at least 6 hours a day, and 1 study told the subject to wear their orthosis up to 16 hours per day.[6,17,19] Rajesh et al[18] did not specify a dosage schedule for the study. The length of time that patients wore the orthoses ranged from 8[17] to 17 weeks.[6,19] Rajesh et al[18] told their subjects to wear their orthoses from 13 to 16 months. Three of the studies[6,17,19] set the orthotic mobilizing force between 200 and 300 g/cm^2, whereas the other study[18] did not specify the force applied (Table 3).

Outcomes

The 4 studies[6,17-19] evaluated the efficacy of orthotic devices to address deficits in PIP joint ROM as a primary outcome measure rather than a patient self-report measure or patient satisfaction with the orthoses. Outcome measures used by the authors[6,17-19] include ROM and Disabilities of the Shoulder, Arm and Hand (DASH) scores. Complications with the device were assessed by 1 author.[19] Each study used a body structure outcome measure (PIP extension) as their primary outcome measure rather than patient self-report measure or patient satisfaction with the orthoses. Only 1 study used a secondary outcome measure, and that self-report measure was the DASH.[6] We were able to calculate the effect sizes of active range of motion (AROM) gains for 2 of the 4 studies, and the effect sizes were large ranging from 0.62 to 1.95.[6,17] Cantero-Téllez et al[6] had an effect size of 1.95 for gains in AROM for the subjects in the experimental group who wore a night static-progressive orthoses and a dynamic daily orthoses. Glasgow et al[17] had an effect size of 1.55 for gains in ROM for the subjects who wore a dynamic Capener orthosis for 12-16 hours per day compared to the effect size of 1.04 for the subjects who wore the device for 6-12 hours per day. Cohen's interpretation of effect size states that any value greater than 0.80 should be considered large indicating a successful treatment intervention.[22] The third and fourth studies[18,19] did not provide enough information to calculate the effect size. Cantero-Téllez et al[6] did not find a statistically significant difference between groups that received traditional therapy compared with the group that received traditional therapy and the orthotic intervention regarding the DASH scores (Table 4).

Rajesh et al[18] reported baseline AROM measurements of flexion and extension of the digits but did not provide final ROM measurements. Rajesh et al[18] provided outcomes using the radiographic

Fig. 2. Night orthotic device.[6]

classification system by Belsky et al.[25] Effect sizes to compare intervention outcomes could not be calculated for these 2 studies due to the limited amount of information provided by the authors.[18,19]

The authors identified variables that may have impacted the results from the studies. Cantero-Téllez et al[6] stated that static and dynamic orthoses might be a viable alternative for improving PIP extension; however, their study lacked a control group; therefore, these results could not be confirmed. The time frame in which subjects sustained a finger injury was between 4 weeks and 6 months that could be the reason for improvements in ROM. Because all subjects received hand therapy it is difficult to establish which intervention was responsible for the results.[6]

Fig. 3. Dynamic extension orthosis.[19]

Fig. 4. Capener orthosis.[17]

Glasgow et al[19] stated that the duration of treatment (first 12 weeks) with dynamic orthoses was an important factor in promoting contracture resolution. However, this study's regression analyses lacked sufficient power to determine the relationship between variables due to a small sample size.[19] This study lacked a control group, which makes it difficult to eliminate the effect of potential confounding variables.[19]

Glasgow et al[17] stated that subjects allocated to the 12-16-hour daily total end range time (TERT) group recorded slightly greater improvements in AROM and total range of motion compared with subjects allocated to the 6-12 hour/d.[17] However, the small sample size limited the power of statistical analyses and increased the risk of type II error.[17]

Rajesh et al[18] stated that subjects with active mobilization of the hand had better results than subjects who received other treatment

Fig. 5. Metacarpophalangeal block orthotic device.[18]

Fig. 6. Metacarpophalangeal blocking orthoses.[18]

modalities. However, this study also had a small sample size and did not provide an adequate data to interpret findings.[18]

None of the authors[6,17-19] gathered data regarding the patient satisfaction or adherence with the orthotic device or complications that arose from the use of the device.

Study quality assessment

The SEQES scores for the quality of research ranged from 43/48 to 23/48 (Table 5). All studies included had methodological flaws. Small sample size was a methodological flaw of all studies.[6,17-19] Two studies did not address the clinical significance of their findings, and the effect size was unable to be calculated.[18,19] One study would be difficult to replicate because the author did not provide a specific intervention protocol.[18] Blinding of the assessor was only successful in one of the studies.[6]

Discussion

Primary purpose

The primary purpose of this systematic review was to determine the efficacy of orthotic devices for increased active PIP joint ROM and determine optimal wearing schedule of the devices to guide clinical practice. Best results were achieved when orthoses were worn for a longer duration. Studies[6,17,19] that provided a wearing schedule of a minimum of 6 hours obtained the greatest improvements in extension deficits of the PIP joint. The mean extension gain was 21°.

This is also the average extension gain reported by Prosser[26] in 1996, with patients who wore a Capener orthosis for 8-12 hours per day for 8 weeks. This is in agreement with the classic study performed by Flowers and LaStayo[27] in 1994 on subjects with PIP flexion contracture treated with serial casting who reported greater gains in PIP extension in the subjects who wore the serial cast longest. Glasgow et al[19] encouraged their subjects to increase their daily TERT of orthotic use if their progress was considered slow. The number of weeks of orthotic treatment and weekly TERT were positively correlated with AROM, time of injury, diagnosis, and joint stiffness.[19] Glasgow et al[19] reported that it is more difficult to regain extension at the PIP joint than flexion, which directly affects the duration of the weeks of treatment with orthoses and ROM gained. Prosser[26] also reported that the longer the PIP contracture was present, the stiffer the joint and the less the contracture resolved. Authors of this systematic review recommend that a dynamic PIP extension orthosis (L3935 [finger orthosis], C/F [custom fabricated], nontorsion joint, bands, may include soft interface, straps, includes fitting and adjustment) be used to treat PIP extension limitations.

Other important clinical considerations that were not highlighted in the 4 studies in this review include timing of surgical interventions and tissue response to applied stress. Nonoperative treatment using orthoses should be tried before a surgical procedure.[28] The effects of orthotic intervention on dense connective tissue need to be considered by the therapist.[29] Patients need to be educated regarding the warning signs of the application of too much force, such as swelling, cyanosis, and tingling.[29] The force should be low enough that the client senses the tension but feels no pain.[30] We recommend an orthotic design that promotes tissue health and healing and allows intermittent joint motion.[29]

Small sample size of the studies and the varying types of studies included in this review may be responsible for the inability to find statistical significance or effect size between different interventions. The sample sizes ranged from 22 to 60 participants; however, all 4 studies included a follow-up above 80% indicating good methodological quality regarding retention of subjects of the studies.[6,17-19]

One study[6] had their participants complete the DASH questionnaire, whereas 2 studies[17,19] used a modified version of the Weeks Test assessment to assess joint stiffness. Flowers and LaStayo[27] suggested using a preconditioning program of heat and stretch to assess the tissue elasticity. The Weeks Test indicates if gains were only 5°, use a static-progressive orthosis if 10°, use a dynamic orthosis; if 15°, use a static design; and if at least 20°, provide active motion exercises and no orthosis.[27]

Secondary purpose

The secondary purpose of this review is to capture the outcome measures used by the authors. The studies[6,17-19] recorded numerical data and body structure outcome measures. This is consistent with a scoping review on the application and management of traction orthotics for intra-articular fractures of the hand.[31] The authors reported that AROM was the most frequently reported outcome followed by pain measurement.[31] Three studies[6,13,15] did not report whether complications or adverse reactions occurred as a result of the orthotic intervention.

McKee et al[29] stated that the therapist should use a patient/client-centered bio-occupational approach that addresses both the client's biological needs and the factors that enable participation in activities that are important and meaningful to the person. Only 1 study[6] used the DASH in their assessment of subjects. Only 1[6] of 4 studies used a standardized functional outcome measure, whereas all studies focused on physical measures as the primary outcome for the study. In a rehabilitation guide for the treatment of flexion contracture of the PIP joint, it is recommended that the patient's social/occupational history and functional limitations should be addressed by the therapist.[32]

There are many factors that could have been considered in terms of the orthotic used for treatment. Authors could have gathered

Table 3
Interventions

Author	Orthoses provided	Dosage schedule	Specifics on protocol	Reassessment time frame performed by therapist	Reported complications
Cantero-Téllez et al[6]	Custom-fabricated night static-progressive orthoses with an elastic material Custom-fabricated dynamic daily orthoses with a nonperforated 2.0 mm thermoplastic material with Orfitube	Wear for 6 h per day and remove for ADLs	Patients completed the DASH questionnaire Orthotic mobilizing force set to 250-300 g/cm^2 Control group received hand therapy treatment Experimental group received a custom-fabricated orthotic device	Once a week	Not provided
Glasgow et al[19]	Custom-fabricated Capener orthoses Custom-fabricated dynamic flexion orthoses, similar design to Capener orthoses	Participants were encouraged to increase daily TERT with orthotic use if ROM progress was slow for 16-17 wk Mean daily TERT for the full sample was 7.7 h Participants were advised to wear their orthoses for 6-12 h per day	Orthotic mobilizing force set to 200-250 g/cm^2 Conduct a modified version of the Weeks Test assessment of joint stiffness Provided diary to document hours of orthoses wear Patients with extension deficits used the Capener orthoses Patients with flexion deficits used the dynamic flexion orthosis	Every 1-2 wk	Difficulty completing work and self-care or domestic tasks while using the orthosis
Glasgow et al[17]	Dynamic Capener orthosis	Group 1: daily TERT 6-12 h a day Group 2: daily TERT 12-16 h a day	Orthotic mobilizing force set to 200-250 g/cm^2 Conduct a modified version of the Weeks Test assessment of joint stiffness Program included dynamic orthotics, AROM, assisted ROM, & edema management Provided diary to document hrs of orthoses wear	Every 1-2 wk	Not provided
Rajesh et al[18]	Custom-fabricated thermoplastic MCP block orthotic device	As tolerated due to swelling and pain No further instruction provided by the authors	Orthosis (force parameters not provided by author) PROM and dynamic extension orthoses if extension lag present Program included AROM exercises (both flexion and extension to digits)	3-4, 8, 10-12 wk, and 13-16 mo	Not provided

ADLs = activities of daily living; DASH = Disabilities of the Shoulder, Arm and Hand; TERT = total end range time; ROM = range of motion; AROM = active range of motion; MCP = metacarpophalangeal; PROM = passive range of motion.

Table 4
Results

Author	Baseline active PIP measurement	Active PIP motion at final assessment	Effect size of the intervention	Effect size between groups	95% CI
	(Mean [SD])				
Cantero-Téllez et al[6]	Control group AROM: (−37 [14.83]) Control group DASH: (37 [37.07]) Experimental group AROM: (−34 [14.22]) Experimental group DASH: (35 [54.83])	Mean improvement in extension AROM in degrees Control group AROM: 9 Control group DASH: 5 points Experimental group AROM: 21 Experimental group DASH: 4 points	Control group AROM: 0.62 Control group DASH: 0.14 Experimental group AROM: 1.95 Experimental group DASH: 0.08	AROM 1.40 DASH 0.02 Favoring the experimental group	AROM baseline (−0.15, 0.56) AROM final (0.99, 1.79) DASH baseline (−0.40, 0.32 DASH final (−0.38, 0.34)
Glasgow et al[19]	Not provided by author	Mean improvement in AROM in degrees Full sample: (29.4 [15.6]) Flexion: (35.1 [17.4]) Extension: (22.0 [8.8])	Not able to calculate	AROM 1.86	Not able to calculate
Glasgow et al[17]	Not provided by author	Mean improvement in extension AROM in degrees Dosage 6-12 h per day: (16.7 [15.63]) Dosage 12-16 h per day: (19.1 [12.00])	Not able to calculate	1.04 AROM 6-12 h 1.55 AROM 12-16 h	Not able to calculate
Rajesh et al[18]	Extension lag in degrees (7 [3.17]) Flexion lag in degrees (17 [7.8])	According to the Belsky classification,[25] 72% (23 patients) excellent 22% (7 patients) good 6% (2 patients) fair to poor	Not able to calculate	Not able to calculate	Not able to calculate

PIP = proximal interphalangeal; SD = standard deviation; 95% CI = 95% confidence interval; AROM = active range of motion; DASH = Disabilities of the Shoulder, Arm and Hand.

Table 5
MacDermid effectiveness study quality checklist

Author	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Cantero-Téllez et al[6]	2	2	2	2	2	1	1	2	2	2	0	2	2	1	2	2	2	1	2	2	2	0	2	2	40
Glasgow et al[19]	2	2	2	2	0	0	1	0	2	2	0	1	2	1	0	2	1	1	2	0	2	2	2	2	31
Glasgow et al[17]	2	2	2	2	2	1	1	1	2	2	2	1	2	2	2	2	2	1	2	2	2	2	2	2	43
Rajesh et al[18]	2	0	2	1	0	1	1	0	2	2	0	2	2	1	0	1	0	1	0	0	0	2	1	2	23

Adapted from Ref. [20].

information regarding the orthotic durability, comfort, and the patient's perception regarding how effective the orthotic was in facilitating gains in PIP extension. The use of different outcome measures for the studies makes statistical comparison more difficult. Not all the studies assessed functional measures, whereas all focused on physical measures as the primary outcome for the study.

Clinical recommendations

The combination of the findings of the studies allows for the following clinical recommendations to be made.

Our review recommends

1. Patients who present with motion deficits of the PIP joint should adhere to a wearing schedule of the orthosis of at least 6 hours per day for the duration of 8-17 weeks.
2. Therapists should address patient satisfaction with the device to ensure a client-centered approach is being used.
3. Therapists should also gather information on adherence and complications to ensure the prescribed dosage of the device is being adhered to.

Best practice suggests

1. The force should be low enough that the client senses the tension but feels no pain.
2. Patients should be instructed to remove the device intermittently for finger ROM exercises to prevent tissue injury.
3. Patients should be instructed to watch for swelling, cyanosis, or tingling that may indicate that too much force is being applied.

Study limitations

Due to the limited sample size in 3 of the studies included in this review,[17-19] further study on this topic is necessary with larger sample sizes that exceed previous sample size calculations. Future studies that examine patient satisfaction and preference concerning the orthotic device would be beneficial. Further studies regarding the orthotic management of PIP joint injuries should ensure that function, adherence, and patient satisfaction are all examined. Also, further studies should present the effect size between groups to address the clinical implications of the study.

In addition, 2 of the studies[6,13] were RCTs, whereas the other 2 studies[18,19] were cohort studies. It is difficult to compare different types of studies, especially with different outcome measures throughout the studies. Future studies should also determine if orthotic use interferes with function of the patient as it relates to their activities of daily living and self-care. To optimize benefits and minimize harmful effects of orthotic intervention, further research on physiological responses of human tissues to immobilization and tension is needed.

Conclusion

This systematic review analyzed the current evidence of orthotic devices for PIP injuries. It investigated recent studies that reported the effectiveness of various orthoses, immobilization methods, and wearing schedules. The duration of treatment with orthoses is the key factor influencing increased active PIP joint ROM. Recommended immobilization duration is for at least 6 hours a day from 8 to 17 weeks.

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Quiz: # 606

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#1. The study design is
   a. RTCs
   b. a case series
   c. a prospective cohort
   d. a systematic review

#2. The acronym TERT is an abbreviation for
   a. Treatment with End Range Traction
   b. Timing of End Ranging Treatment
   c. Total End Range Time
   d. Total Endurance + Resistive Treatment

#3. The work of _____ validated the original work of _____
   a. Glasgow and Prosser, Flowers and LaStayo
   b. McKee and Chinchalkar, Michlovitz and Fedorczyk
   c. Freeland and Hardy, Fess and Bell
   d. Brand and Bell, Hunter and Mackin

#4. "Best practices" suggests that the orthotic, end range device be applied such that
   a. the patient cannot feel any tension, nor any pain
   b. the patient feels some tension, but no pain
   c. the patient feels slightly bearable pain
   d. the patients feels a slight increase in temperature of the PIP joint

#5. The recommended average TERT is on the order of 6-8 hours per day
   a. false
   b. true

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