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INTEGRATED STUDY MASTER'S THESIS

1st Carpometacarpal (CMC) Joint Arthritis: Treatment Options, Surgical Techniques and Results. Systematic Literature Review

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Abbreviations.

CMC	Carpometacarpal
TMC	Trapeziometacarpal
OA	Osteoarthritis
ROM	Range of Motion
LRTI	Ligament reconstruction and tendon interposition
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
NSAIDs	Non-steroidal anti-inflammatory drugs
(cs-, ts-, b-)DMARDs	(conventional synthetic, targeted synthetic, biologic) Disease-modifying anti-rheumatic drugs
PRP	Platelet-rich plasma
RCTs	Randomized controlled trials
N/A	Not applicable
GM-CSF	Granulocyte-macrophage colony-stimulating factor
IL	Interleukin
PDE4	Phosphodiesterase-4
SNRIs	Selective norepinephrine reuptake inhibitors
TNF	Tumor necrosis factor
VAS	Visual analogue scale
AUSCAN	Australian/Canadian OA Hand Index
MCP	Metacarpophalangeal
IAI	Intra-articular injection
PEMF	Pulse electromagnetic field
DASH	Disabilities of the Arm, Shoulder, and Hand
QDASH	Quick Disabilities of the Arm, Shoulder, and Hand
STT	Scaphotrapeziotrapezoidal
LRTI	Ligament reconstruction and tendon interposition

Abstract.

Introduction

First carpometacarpal joint arthritis, also known as basal thumb arthritis, is a common condition affecting the aging population, leading to pain and decreased function of the hand. Treatment varies and focuses on symptoms alleviation and improvement of function. Currently there is no consensus on gold standard treatment of first carpometacarpal joint arthritis, therefore further studies are in need.

This review aims to summarize the current available treatment options and potentially effective measures for first carpometacarpal joint arthritis, including conservative and surgical interventions. Highlights the effectiveness of interventions and the potential risks of complications.

Methods

Literature search through the PubMed database, apply filters with “meta-analysis” and “full-text articles available”, and source literature with keywords. Establish a systematic literature review via the Preferred Reporting Items for Systematic reviews and Meta-Analyses flow chart, selection through the PubMed platform.

Results and discussion

38 studies are identified and included in this review, including 30 conservative treatment studies and 8 surgical treatment studies. 1 dietary study was found, and it shows no effectiveness in osteoarthritis. 14 pharmacological treatment studies, only a few substances show effectiveness, oral non-steroidal anti-inflammatory drugs and oral corticosteroids have a consistent effectiveness among all studies. Novel synergistic drugs GCSB-5 and CRx-102 have effectiveness on hand osteoarthritis but are not used on a regular basis. Injection therapies are ineffective in these studies. 14 physical therapy-related studies, with another study including both pharmacological and physical therapy. Most physical therapies in these studies show effectiveness on hand osteoarthritis and first carpometacarpal joint arthritis, including orthoses or splints, exercise-based therapy, heat therapy,

and pulse electromagnetic field therapy. Acupuncture has a doubtful outcome, and further research is recommended. 8 surgical studies are included in this review, including autologous fat and platelet-rich plasma injections, arthroscopic-assisted techniques, first metacarpal extension osteotomy, arthrodesis, simple trapeziectomy, trapeziectomy with ligament and tendon interposition, and joint replacement surgeries. All these surgical techniques show effectiveness in pain and function improvement, apart from the first metacarpal extension osteotomy, which does not improve the function of the hand.

Conclusion

First carpometacarpal arthritis has various treatment options, this review has its limitations due to the inability to find other known interventions studies with meta-analysis. Initial treatment is recommended to treat oral non-steroidal anti-inflammatory drugs, corticosteroids, splints, exercise, heat, and pulse electromagnetic field. Surgical treatment options recommended for early-stage disease are treated with autologous fat and platelet-rich plasma injections; Later stages are treated with simple trapeziectomy, trapeziectomy with ligament and tendon interposition, and joint replacement.

Keywords. Carpometacarpal joint, trapeziometacarpal, osteoarthritis, thumb arthritis, hand arthritis, rhizarthrosis.

1. Introduction.

1st Carpometacarpal (CMC) joint arthritis or osteoarthritis(OA), also referred to as basal thumb arthritis or trapeziometacarpal (TMC) arthritis and rhizarthrosis, is a relatively modern disease yet commonly treated in nowadays clinical practice. Year after year, the world's aging population has been increasing, the prevalence of 1st CMC joint osteoarthritis is rising, and it has become one of the main issues affecting the quality of living in the aging population(1).

The main complaint of 1st CMC OA is pain, and in further progression of disease stages, hand function may be affected, including reduced range of motion (ROM), increased joint stiffness, decreased grip and pinch strength, therefore, the main strategy of treatment is to alleviate these symptoms. The general approach to 1st CMC OA initially is conservative or non-operative treatments, such as pharmacological treatment and physical therapy. When the symptoms are not alleviated or improved, surgical treatment could be introduced, and the choice of treatment options may be based on the stages of disease(Eaton-Litter stage I, II, III, and IV)(1–3). However, there is no gold standard to treat this disease, and treatment varies from country to country, institution to institution, and even between surgeons.

There is one study involved members of American Society for Surgery of the Hand about surgeon preferences on type of surgical treatments options, the most preferred technique is trapeziectomy with ligament reconstruction and tendon interposition(LRTI) about 40%, second most preferred is trapeziectomy with suspensionplasty about 28%, the other techniques preferences percentages are more dispersed, and the reason of the preferences are mainly due to the technique's simplicity and familiarity(4).

Nevertheless, the choice of treatment depends on the institution and surgeon's ability or availability and should be taken into consideration for the best interest of the patient, thus, research of the effectiveness and comparison of these treatments are important. The research in treatment for 1st CMC arthritis is novel and still requires more studies.

This systematic literature review aims to summarize the current treatment options that are available and potentially effective for 1st CMC joint arthritis, including non-surgical(conservative) and surgical(invasive) techniques.

2. Methods.

2.1. Literature Search Strategy.

A digital literature search was conducted, and meta-analysis studies were searched through the PubMed database. The meta-analysis studies that are relevant to this topic are relatively young, therefore, there is no restriction on filtering literature published year. The review is performed according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) report guidelines(5,6). Literature collection and selection processes are carried out through the PubMed account platform.

2.2. Inclusion and Exclusion Criteria

In this review, literatures that are related to the treatment of 1st CMC joint and hand osteoarthritis are included; treatment could be either conservative or invasive and/or surgical. Only literature conducted with meta-analysis was selected, and only full-text articles that are accessible were included in this review. Literature excluded from this review in the initial screening was literature that the title and abstract were not related to the topic of this review. In the further screening process, one of the reports was found in withdrawn status that was not retrieved; other exclusion criteria included full-text articles inaccessibility, discussion without hand joints, without meta-analysis, and insufficient review on hand joints.

2.3. Literature Selection

The search is filtered only with article type in meta-analysis and full-text availability; keywords used in literature sourcing are presented in Table 1. Identified records of literature were saved to the PubMed account collection, the duplicates were removed automatically while adding the records to the collection. The screening process is shown below in Figure 1 using the PRISMA flow diagram, manually screened and excluded ineligible records.

Table 1. Initially identified records with different keywords

Keyword	Records
Thumb arthritis	25
Thumb	26
CMC arthritis	8
Carpometacarpal joint arthritis	22
Hand osteoarthritis	169
Basal thumb arthritis or osteoarthritis	1
Trapeziometacarpal	12
Rhizarthrosis	1

Abbreviation: CMC, Carpometacarpal.

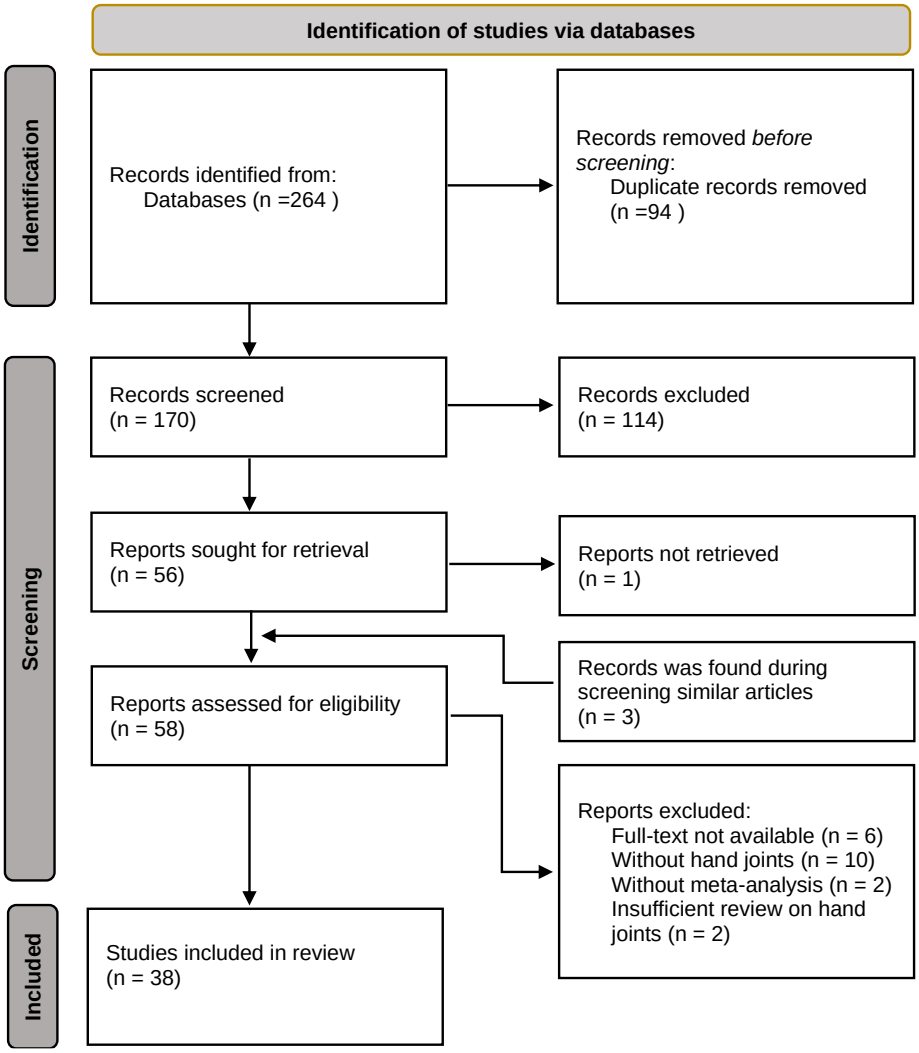

Figure 1. PRISMA Flow Diagram of Literature Selection

3. Research results.

3.1. Results of selected studies

38 studies are included in this review after the selection process, including 1 dietary supplement study, 14 pharmacological approach studies, 14 physical therapy-related studies, 1 mixed conservative treatments study, and 8 surgical approach studies. Table 2 summarizes the results of the selection of studies that are included in this review.

Table 2. Summary of treatment types in studies after selection.

Treatment types in studies	Author(s), Year	Number of studies
Conservative		30
Dietary supplements	Liu et al., 2018(7)	1
Mixed pharmacological interventions	Wu et al., 2024; Døssing et al., 2023; Riley et al., 2019; Trellu et al., 2015(8–11)	4
Non-steroidal anti-inflammatory drugs, NSAIDs	Berenbaum et al., 2005(12)	1
Corticosteroids	Estee et al., 2022; Krez et al., 2024; Wang et al., 2022; Donovan et al., 2022 (13–16)	4
Disease-modifying anti-rheumatic drugs, DMARDs	Mathieu et al., 2022; Persson et al., 2018; Singh et al., 2022(17–19)	3
Osteoporotic drug(Bisphosphonates)	Davis et al., 2013(20)	1
Anti-gout agent(Colchicine)	Singh et al., 2023(21)	1
Mixed conservative treatments	Veronese et al., 2021(22)	1
Mixed physical therapy	Ahern et al., 2018(23)	1

Table 2. Summary of treatment types in studies after selection. (*continued*)

Treatment types in studies	Author(s), Year	Number of studies
Conservative		
Exercise-based interventions	Huang et al., 2024; Karanasios et al., 2024; Osteras et al., 2017; Magni et al., 2017(24–27)	4
Orthoses or Splint	Marotta et al., 2021; Meireles et al., 2019; Buhler et al., 2019(28–30)	3
Splint and exercise	Kjeken et al., 2011(31)	1
Hydro and balneotherapy	Bender et al., 2014(32)	1
Pulse electromagnetic field	Tong et al., 2022; Wu et al., 2018(33,34)	2
Acupuncture	Manheimer et al., 2010(35)	1
Surgical		8
Autologous fat and PRP injection	Winter et al., 2023(36)	1
Arthroscopic interventions	Wilkens et al., 2018(37)	1
Osteotomy	Chiang et al., 2023(38)	1
Arthrodesis	Kim et al., 2025(39)	1
Arthroplasty	Liu et al., 2022; Raj et al., 2022; Liukkonen et al., 2024; Seth et al., 2024(40–43)	4

Abbreviations: NSAIDs, non-steroid anti-inflammatory drugs; DMARDs, disease-modifying anti-rheumatic drugs; PRP, Platelet-rich plasma

3.2. Non-surgical/conservative treatment options:

There are 31 studies with non-operative/conservative treatments that were selected. In this review, conservative treatment type is categorized: dietary supplements; pharmacological treatment with either topically applied, orally consumed, and/or injection; physical therapy related, including exercise-based, orthoses, hydro- and balneotherapy, pulse electromagnetic field, and acupuncture.

3.2.1. Dietary supplements

There is 1 study treated with dietary supplements, Liu et al., 2018(7) did an analysis of various dietary supplements efficacy in treating osteoarthritis, although it's a study with osteoarthritis in general including hip, knee and hand joints involvement, the study included 2 randomized controlled trials (RCTs) of hand OA, which is 3% of total RCTs in the study for analysis, might be worth discussing as a potential treatment. In this study, 20 types of supplements were analyzed, of which glucosamine and chondroitin were the most used. Liu et al. stated that in their review, the supplements have shown no clinically significant improvement in pain and physical function, and due to the small number of RCTs studies of hand OA, further research in dietary supplements efficacy in hand OA is required(7).

3.2.2. Pharmacological treatments

There are 12 reports analyzing pharmacological agents' efficacy on OA, including 4 studies of mixed pharmacological interventions, 1 study of NSAIDs, 4 studies of corticosteroids, 3 studies of DMARDs, 1 study of osteoporotic drugs, and 1 study of anti-gout agents.

The mixed pharmacological interventions' studies that have included in this review, 2 of them are study of hand OA, the other 2 are study of injection-based therapy of thumb OA(1st CMC joint), the agents that are analyzed in these 4 studies are summarized in table 3.

In Wu et al., 2024(8) and Døssing et al., 2023(9) studies, both analyzed various drugs' efficacy on hand OA, however, Døssing's study included intra-articular injection interventions more than Wu's study. On the other hand, Wu's study assessed the efficacy and safety of drugs.

Wu's study performed meta-analysis on 20 different drugs including biological agents(bDMARDs), antimetabolic drugs(methotrexate, colchicine, diacerein), intra-articular neuromuscular blocker injection, NSAIDs, corticosteroid, substantial release(SR) paracetamol, novel herbal based abstracted synthesized drug GCSB-5, novel synergistic drug CRx-102, hypertonic dextrose, cannabidiol, and chondroitin sulfate. They concluded that novel synergistic drugs combining with bDMARDs have the most effective outcomes in treating and preventing hand OA. With the combination, the adverse reaction is lower than just using biologic agents alone, and there is the most improvement in pain, stiffness, and hand function(8).

Døssing's study analyzed on 29 different pharmacological interventions including supplements, unsaponifiables, topical treatments, anti-gout drug(colchicine), osteoporotic drug(bisphosphonates), injection-based treatment, DMARDs, oral NSAID, oral corticosteroids, antiepileptics, paracetamol, SNRIs, cannabidiol, and radiation(in the study stated it is considered as a pharmacological treatment in Denmark). Døssing's study concluded that oral NSAIDs and oral corticosteroids are most effective in pain and function. They also analyzed intra-articular injections in thumb OA, they concluded that none of the injection-based therapies are effective in thumb OA(9).

Riley's study(10) and Trellu's study(11) both analyzed injection-based therapy in thumb OA, and both analyzed the same agents' efficacy on pain and function. The analyzed injection therapy agents are corticosteroid, hyaluronic acid, and dextrose. Riley's study concluded that the effectiveness of the injection of those agents is doubtful and does not suggest superiority to placebo. On the other hand, Trellu's study stated that corticosteroid injection decreased the pain at week 24, and hyaluronic acid improved functional capacity at week 12. However, given the fact that Riley's

study(2019) is 4 years younger than Trellu's study(2015), Riley's study might have a more accurate conclusion due to the larger sample size and more trials were analyzed. The results from both studies stated a similar opinion that the injection treatment needs furthermore research and confirmation due to the great heterogeneity of outcomes in the trials they analyzed.

Table 3. Pharmacological agents in mixed intervention studies

Type of agents	Wu et al., 2024(8)	Døssing et al., 2023(9)	Riley et al., 2019(10)	Trellu et al., 2015(11)
Oral				
Supplements	Chondroitin sulfate	Glucosamine, Galactosaminoglycuronglycan sulfate, Chondroitin sulfate	N/A	
csDMARDs	Methotrexate (Antimetabolic drug)	Hydroxychloroquine, Methotrexate		
tsDMARDs	-	PDE4 inhibitors		
bDMARDs	Lutikizumab, Tocilizumab, Etanercept, Adalimumab,	TNF inhibitors, IL-1 inhibitors, IL-6 inhibitor, GM-CSF inhibitor		
Paracetamol	+	+		
NSAIDs	Celecoxib, Lumiracoxib, NAXOZOL	+		
Corticosteroids	Prednisolone	+		
Anti-gout agents	Colchicine (Antimetabolic drug)	Colchicine		

Table 3. Pharmacological agents in mixed intervention studies (*continued*)

Type of agents	Wu et al., 2024(8)	Døssing et al., 2023(9)	Riley et al., 2019(10)	Trellu et al., 2015(11)
Oral				
Osteoporotic drug	-	Bisphosphonates		
Antiepileptics	-	+		
Novel synergistic drug	GCSB-5, CRx-102	-		
Others	Diacerein (Antimetabolic drug), Hypertonic dextrose, cannabidiol	SNRIs, Cannabidiol, Unsaponifiables		
Topical				
NSAIDs	Diclofenac Sodium Gel	+	N/A	
Others	-	Capsaicin, salicylate		
Injection				
Intra-articular Neuromuscular blocker	Botulinum toxin A	-	-	-
Perineural corticosteroids	-	+	-	-
Intra-articular Corticosteroid	+	+	+	+

Table 3. Pharmacological agents in mixed intervention studies (*continued*)

Type of agents	Wu et al., 2024(8)	Døssing et al., 2023(9)	Riley et al., 2019(10)	Trellu et al., 2015(11)
Injection				
Intra-articular Hyaluronic acid	-	+	+	+
Intra-articular Dextrose	-	+ (Prolotherapy)	+	+
Others	-	Salicylate injection, Intra-articular PRP	-	-
Other interventions				
Radiation	-	+	-	-
Conclusion of efficacy				
	Novel synergistic drugs with bDMARDs have the most effective outcomes in hand OA.	Oral NSAIDs and oral corticosteroids are most effective in hand OA; injection-based therapy is ineffective in thumb OA	Doubtful effectiveness in thumb OA	

+, included in the study; - and N/A, not included in the study. Abbreviations: N/A, not applicable; (cs-, ts-, b-)DMARDs, (conventional synthetic, targeted synthetic, biologic)Disease-modifying anti-rheumatic drugs; GM-CSF, granulocyte-macrophage colony-stimulating factor; IL, interleukin; NSAIDs, non-steroidal anti-inflammatory drugs; PDE4, phosphodiesterase-4; SNRIs, selective norepinephrine reuptake inhibitors; TNF, tumor necrosis factor; PRP, platelet-rich plasma; OA, Osteoarthritis.

The other 10 reports of studies are mostly targeted at single-class medication analysis. Table 4 summarizes the agents that were analyzed in the studies and their results. Most of the studies are research in OA in general with containing results of hand OA, only a few solely on hand OA, and only Krez's study focuses on 1st CMC joint. These studies show that these medications have limited effectiveness in hand OA, and some have limited study numbers for researching hand OA. Only one study in these reports shows effectiveness on hand OA, Berenbaum et al., 2005 study shows Lumiracoxib has improvement in pain and function. The study's conclusion of Table 4 is focused on hand OA and 1st CMC or TMC.

Table 4. Summary of studies with specific pharmacological agent analysis

Studies	Agents	Conclusion
NSAIDs		
Berenbaum et al., 2005(12) OA	Lumiracoxib	Lumiracoxib improves pain and function in OA patients significantly. Hand OA patients in a short-term(4 weeks) study seem to have a significant improvement in visual analogue scale (VAS) and Australian/Canadian OA Hand Index (AUSCAN), with no difference in effectiveness between the dosages(200mg and 400mg).
Corticosteroids		
Estee et al., 2022(13) Hand OA	Oral and intra-articular injection(IAI) corticosteroids	Short-term(4-6 weeks) treatment: little improvement in both pain and stiffness with oral corticosteroids; on the other hand, IAI corticosteroids have no significant improvements.

Table 4. Summary of studies with specific pharmacological agent analysis (*continued*)

Corticosteroids		
		In medium-term(3-12 months) treatment: corticosteroids have no effectiveness. Low-quality evidence needs further research.
Krez et al., 2024(14) 1st CMC OA	IAI corticosteroids, IAI hyaluronic acid, IAI PRP	Short-term: No difference in improvement in pain and function compared to other IAI agents. Medium-term: No difference. The effectiveness of IAI corticosteroids
Wang et al., 2022(15) Hand OA	Unspecified corticosteroids	Due to significant heterogeneity, the issue needs to be further researched. Doubtful conclusion of improvement in hand OA pain and function.
Donovan et al., 2022(16) OA	IAI corticosteroids, IAI hyaluronic acid, IAI PRP, IAI saline/orgotein	Medium-term(>3 months): IAI corticosteroids are not superior to others at 3 months and 6 months in terms of pain improvement, and at 3 months in terms of function of TMC. It is inferior to others after 12 months in pain, 6 months and 12 months in function improvement.
DMARDs		
Mathieu et al., 2022(17) OA	Methotrexate, hydroxychloroquine, TNF, and IL-1 inhibitors	Generally, ineffective on hand OA in pain and function, only TNF inhibitors show improvement in reducing swelling and inflammatory markers.
Persson et al., 2018(18) OA	Methotrexate, hydroxychloroquine, adalimumab,	Improvement of DMARDs is not clinically significant, no difference between hand OA and knee OA.

Table 4. Summary of studies with specific pharmacological agent analysis (*continued*)

DMARDs		
	anakinra, etanercept, infliximab	
Singh et al., 2022(19) OA	Hydroxychloroquine	Hydroxychloroquine is ineffective in pain and function in hand OA.
Antigout agents		
Singh et al., 2023(21) OA	Colchicine	Colchicine is ineffective in pain and function in hand OA.
Osteoporotic drug		
Davis et al., 2013(20) OA	Bisphosphonates	They found one study had compared effectiveness of bisphosphonate with hydroxychloroquine treating with hand OA, they stated bisphosphonate is statistically significant improvement in pain and better patient global assessment scores than hydroxychloroquine.

The studies column includes the author of the study, and below the author is the targeted disease.

Abbreviations: NSAIDs, non-steroidal anti-inflammatory drugs; OA, Osteoarthritis; CMC, Carpometacarpal; TMC, Trapeziometacarpal; IAI, intra-articular injection; PRP, platelet-rich plasma; TNF, tumor necrosis factor; IL, interleukin; DMARDs, Disease-modifying anti-rheumatic drugs.

Pharmacological interventions seem to have only limited effects on 1st CMC OA; only oral NSAIDs and oral corticosteroids have a consistent effectiveness among all studies that are included in this review. Only Wu's study mentioned about the novel synergistic drug GCSB-5 and CRx-102 have

effectiveness on hand OA, which could be looked into for further research(8). None of the pharmacological injection therapies mentioned in this review are effective in treating 1st CMC OA.

3.2.3. Physical therapy-related treatments

14 physical therapy-related studies, including various types of treatments, 2 of which include multiple modalities treatments, and others focused on a single type of therapy.

Veronese's study analyzed conservative treatments for hand OA with both pharmacological and physical therapy. They concluded that none of the pharmacological interventions are effective except intra-articular hyaluronic acid improved function in thumb OA. On the other hand, nonpharmacological therapy, splints, is significantly effective in pain relief in 1st CMC OA, and resistance training could reduce a small amount of pain. However, due to the low to moderate evidence level of certainty, further study is needed(22).

Ahern's study analyzed the effectiveness of various physical therapy modalities in 1st CMC joint treatment. They analyzed multiple modalities such as exercise, heat, orthoses, neurodynamic techniques, joint mobilization, and passive accessory mobilizations. They pooled and analyzed unimodal and multimodal treatments, and it shows that these physical therapies seem to have clinical effectiveness in pain on both unimodal and multimodal therapy, and multimodal therapy has more effectiveness on function improvement than unimodal(23).

The other physical therapy related studies and the 2 above-mentioned studies are summarized in table 5 with a similar fashion on table 4.

Table 5. Summary of studies with physical therapy-related treatments

Studies	Modalities	Conclusion
Veronese et al., 2021(22) Hand OA	IAI hyaluronic acid, splints, physical training, and resistance training	IAI hyaluronic acid improved the function of thumb OA. Splints are effective in pain relief.
Ahern et al., 2018(23) 1st CMC OA	Exercise, heat, orthoses, neurodynamic techniques, joint mobilization, and passive accessory mobilizations.	Unimodal and multimodal physical therapies are effective in pain and function improvement.
Huang et al., 2024(24) Hand OA	Exercise-based	Immediate term: improvement of pain, function, and grip strength, except pinch strength and quality of life. (Low evidence) Long-term: ineffective.
Karanasios et al., 2024(25) 1st CMC OA	Exercise-based	Short-term: improvement in pain and function. (Moderate evidence) Different types of exercise have no significant changes in effectiveness.
Osteras et al., 2017(26) Hand OA	Exercise-based	Immediate term: improvement in pain and function. (Low evidence)
Magni et al., 2017(27) Hand OA	Resistance training	Ineffective function improvement, small effect in pain relief. (Low evidence)

Table 5. Summary of studies with physical therapy-related treatments (*continued*)

Studies	Modalities	Conclusion
Marotta et al., 2021(28) 1st CMC OA	2 rigid splints, 2 soft splints Rigid: Short thermoplastic CMC splint, long thermoplastic CMC-MCP splint Soft: short neoprene CMC splint, long neoprene CMC-MCP splint	Comparison of different types of splints. Best pain improvement: long thermoplastic CMC-MCP splint Best function improvement: short thermoplastic CMC splint
Meireles et al., 2019(29) 1st CMC OA	Orthoses or Splint	Short-term: ineffective Long-term: improvement in pain and function. (low evidence)
Buhler et al., 2019(30) 1st CMC OA	Orthoses or Splint	Short-term: ineffective Medium-term: improvement in pain(moderate to large) and function(small to moderate). (low evidence) No differences between rigid and soft splints, and with or without MCP involvement. (low evidence)
Kjeken et al., 2011(31) Hand OA	Splint and exercise	The first study included a meta-analysis of the effectiveness of splint and exercise in hand OA.

Table 5. Summary of studies with physical therapy-related treatments (*continued*)

Studies	Modalities	Conclusion
		Splint improvement in pain in either short-term or long-term, doubtful effectiveness in function improvement. Exercise alone and in combination with a splint has limited evidence of effectiveness.
Bender et al., 2014(32) OA	Hydro- and balneotherapy(Heat)	Effective in short-term and long-term treatment of hand OA.
Tong et al., 2022(33) OA	Pulse electromagnetic field(PEMF)	Effective improvement of pain and function with low-frequency PEMF treatment on hand OA.
Wu et al., 2018(34) OA	Pulse electromagnetic field(PEMF)	Effective improvement of pain and function with short-duration (30 minutes) PEMF treatment on hand OA.
Manheimer et al., 2010(35) OA	Acupuncture	Due to doubtful effectiveness, further research is needed.

The studies column includes the author of the study, and below the author is the targeted disease.
Abbreviations: OA, Osteoarthritis; CMC, Carpometacarpal; MCP, metacarpophalangeal; IAI, intra-articular injection; PEMF, Pulse electromagnetic field.

Physical therapies have various outcomes in different modalities. The immobilization of the joint with orthoses or splint has a consistent result throughout different studies, with significant improvements in pain in long-term treatment, and some improvement in function. The materials of splints seem to have different outcomes; the example of splints with or without MCP joint

involvement is shown in Figure 2. Marotta(28) and Buhler(30) have different conclusions on the effectiveness difference in materials and MCP joint involvement, but given the fact that Buhler's study is published 2 years older with a low evidence level, Marotta's study might have a more accurate result. The 2 rigid splints seem to have the best outcomes, long thermoplastic CMC-MCP splint has the best pain improvement, and short thermoplastic CMC splint has the best function improvement. Exercise-based therapies seem to have improvement in pain and function at least in the immediate term, and different types of exercise have no significant differences(24–27,31). Heat therapy seems to be effective in short-term and long-term treatment in hand OA, it might be beneficial in treating 1st CMC OA as well(32). The 2 pulse electromagnetic field studies have similar conclusions towards hand OA treatment, which has effective improvement of pain and function with low-frequency and short duration PEMF(33,34). Acupuncture could be a potential treatment; however, it still requires more research (35). Unimodal or multimodal physical therapies are both beneficial in pain and function improvement, and more effective with multimodal(23).

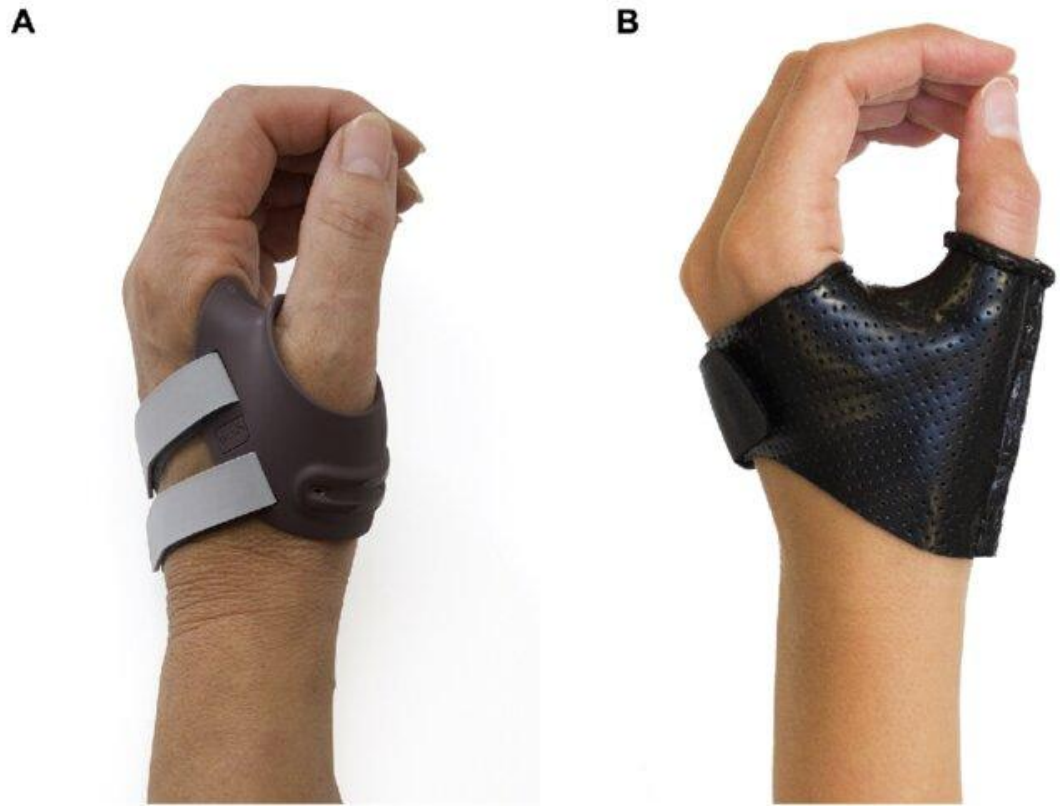

Figure 2. Example of a CMC joint splint without MCP joint involvement(A); With MCP joint involvement(B). (44)

3.3. Surgical treatment options:

Surgical treatments that are included in this review are all targeted at 1st CMC joint arthritis; 7 studies were found relevant and included in this review. The type of surgical interventions, including autologous fat and PRP injection(36), arthroscopic interventions(37), osteotomy(38), arthrodesis(39), trapeziectomy and trapeziectomy with ligament reconstruction and tendon interposition(40,41), total joint arthroplasty or joint replacement, or implants(41–43).

3.3.1. Autologous fat and PRP injection

Winter's study technique involves the patient's autologous fat harvesting and autologous PRP by extracting from centrifuged venous blood(45). This technique is simple, fast, minimally invasive, and the complications are small; the required equipment is also simpler than other surgical interventions. In their meta-analysis, they found that this intervention could reduce the pain by 2 to 3 VAS points, and the function is also improved. They also found out from other studies reported that this kind of treatment might be ineffective in later stages of disease(stage III and above), which might cause their study result to have high heterogeneity because the meta-analysis they performed included all stages of disease (stage I-IV). Therefore, they concluded that this treatment is effective in pain and function improvement, but more RCTs are required for research(36).

3.3.2. Arthroscopic interventions

Arthroscopic-assisted technique involvement in 1st CMC OA has different types of surgery such as simple as debridement to complex as total joint arthroplasty.

Winlkens's study performed a meta-analysis on arthroscopic-assisted techniques, including various types of surgery, to analyze the effectiveness. They found out that the arthroscopic-assisted techniques are effective, improving pain in around 4.1 VAS, and improved function in Disabilities of the Arm, Shoulder and Hand(DASH) scores by 22 points and grip strength by 2.8kg, with doubtful superiority compared to conventional surgeries. However, this meta-analysis evidence is

limited, as it did not include any RCTs. Therefore, further studies are required to understand the benefits compared to the conventional surgical techniques.

3.3.3. Osteotomy

The 1st CMC OA treatment with osteotomy is targeted at the 1st metacarpal bone. 1st metacarpal osteotomy is usually treated with early-stages(I-II) patients, and it has several contraindications(1), this approach involving removing of the part of the 1st metacarpal bone to relief the load of volar part of thumb, figure 3 demonstrates the basics of the procedure steps.

Chiang's study did a meta-analysis of the effectiveness of 1st metacarpal extension osteotomy in pain and function improvement. In this study, the patients reported outcomes they analyzed, the VAS pain scale is not unified; some are 0-9, the others are 0-7. Nonetheless, they found that this procedure effectively improved pain, but the function in grip and pinch strength was not improved in the long-term follow-up(38). It is foreseeable that the function improvement is limited, due to the nature of this surgical procedure, the CMC joint itself is left untreated. They concluded that although it is an effective measure in treating pain, the function improvement is limited; further study should include comparison with other surgical treatments.

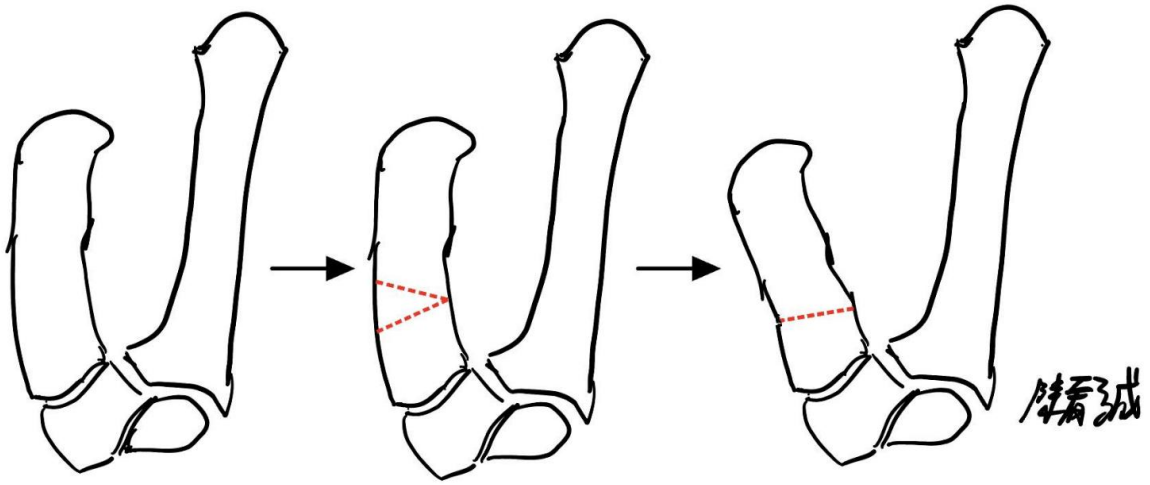

Figure 3. 1st metacarpal extension osteotomy scheme. (Drawn by the author of this review)

3.3.4. Arthrodesis

Arthrodesis differs from other surgical treatments, as it fixes and prevents movement of 1st CMC joint, therefore preventing pain caused by the movement of the joint. It could be indicated for medium stages of disease(stage II-III) and contraindicated with scaphotrapeziotrapezoidal(STT) OA, was known for giving stronger grip strength and used to perform on workers involving hand labor, but due to the complications of nonunion, surgeons are refrained from performing this surgery with the lowest preferred percentage from United States hand surgeons(4,39,46). Figure 4 shows an example of an arthrodesis post-operation.

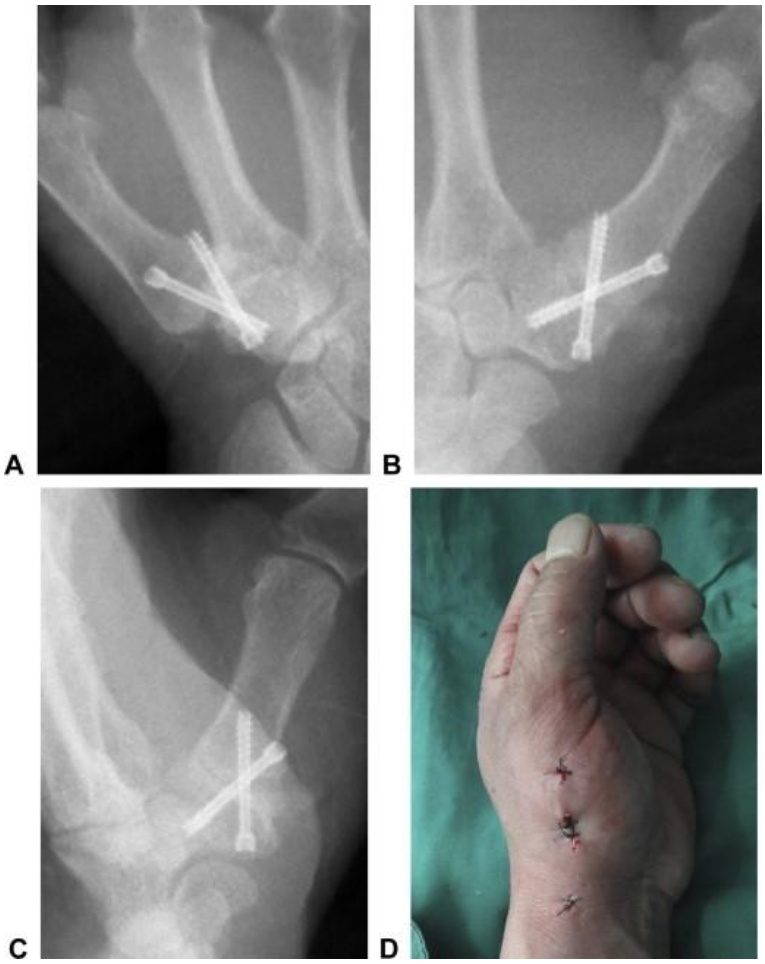

Figure 4. Post operated arthrodesis with headless screws and arthroscopic assistance(47).

Kim's study compared the effects of arthrodesis to ligament reconstruction and tendon interposition(LRTI) and performed a meta-analysis. They found out that arthrodesis has no

significant differences compared to LRTI in improvement of pain and function, except that the key pinch strength is weaker in LRTI. However, the reoperation rate is much higher in arthrodesis due to the complications, which are mainly nonunion. Even though the improvement of key pinch strength in LRTI is weaker than arthrodesis, it is still significantly better than pre-operation, thus LRTI would be a more preferable surgical option than arthrodesis in terms of a lower complication rate.

3.3.5. Arthroplasty

Arthroplasty for 1st CMC OA has several approaches, the arthroplasty surgery that was found and included in this review are trapeziectomy, trapeziectomy with LRTI, total joint arthroplasty, joint replacement and other types of trapezium implants. Figure 5 demonstrates trapeziectomy with LRTI mechanism and figure 6 shows an example of CMC joint replacement scheme.

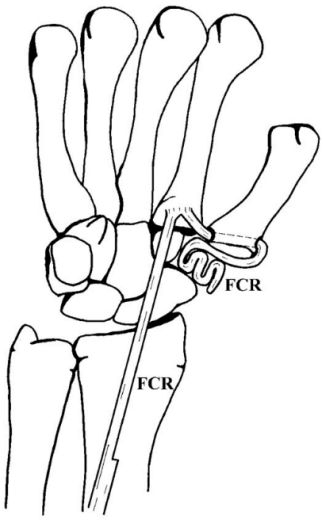

Figure 5. Example of trapeziectomy with LRTI by using Flexor Carpi Radialis(FCR)(48).

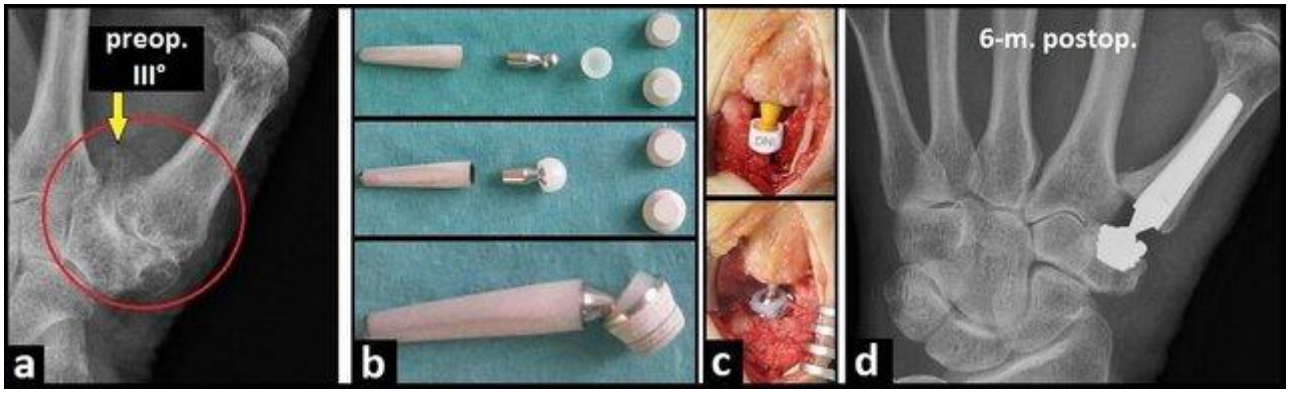

Figure 6. CMC joint replacement scheme with implants(49).

Liu's study did a meta-analysis comparing trapeziectomy to trapeziectomy with LRTI. They found that there are no significant differences in short-term post-operation, but in long-term effect, trapeziectomy with LRTI has more improvement in grip and pinch strength than trapeziectomy alone. However, given the fact that trapeziectomy with LRTI are more traumatic, short-term postoperative complications are higher than simple trapeziectomy, they recommended simple trapeziectomy if no need of extra grip and tip pinch strength(40).

Raj's study did a meta-analysis comparing trapeziectomy to joint replacement(implant). In this analysis, they could only include Quick DASH(QDASH), key pinch, and VAS, it was due to the data they found had incomplete parameters, therefore, other functions were not analyzed. They found out that joint replacement has a more favorable outcome in QDASH, key pinch, and VAS score than simple trapeziectomy. However, the complication rate and reoperation rate are higher in joint replacement surgery, and the outcomes differ from the materials for joint replacement surgery. The evidence level they found in their study is very low to moderate; therefore, further research with a more standardized including complete parameters, is recommended(41).

Liukkonen's study did a meta-analysis comparing trapeziectomy to total joint arthroplasty(implant); this study was published 2 years later than Raj's study, and therefore might provide a more accurate outcomes comparison. They found that pain improvement is similar in both approaches, and function improvement seems superior in joint replacement only in the short term, but grip and pinch strength improvements are still better in joint replacement compared to simple trapeziectomy(42). The differences between Liukkonen's study and Raj's study are that they found that after excluding the outliers, the reoperation rate of joint replacement surgery is lower than simple trapeziectomy. However, the risk of bias of the studies they included in their analysis is present, therefore, research on this topic is still necessary. Nevertheless, this shows joint replacement surgery has its potential to have a better outcome than simple trapeziectomy.

Seth's study analyzed different trapezium implants of efficacy and safety, including total joint replacement, hemiarthroplasties, interpositions with partial trapezial resections, and interpositions with total trapezial replacements. They analyzed 3 parameters, including pain(VAS), grip strength, and DASH scores. They found that total joint replacement has the best improvement in pain among others, but the implant failure rate is also the highest. Interposition with partial trapezium resection surgery, on the other hand, has the best grip strength and DASH scores. However, due to the heterogeneity and limited number of studies, further RCTs are recommended(43).

Table 6 summarizes the surgical modalities that are mentioned above in this section.

Table 6. Summaries of surgical treatment options

Studies	Modalities	Conclusion
Winter et al., 2023(36)	Autologous fat and PRP injection	Effective improvement of pain and function in the early stages of the disease.
Wilkens et al., 2018(37)	Arthroscopic interventions	Effective improvement of pain and function, uncertainty of benefit compared to other conventional surgeries.
Chiang et al., 2023(38)	Osteotomy	Effective improvement of pain, but ineffective in function improvement.
Kim et al., 2025(39)	Arthrodesis, LRTI	Effective improvement of pain and function in both modalities, LRTI has less improvement in key pinch, but arthrodesis has a high revision surgery rate.
Liu et al., 2022(40)	Trapeziectomy, trapeziectomy with LRTI	Effective improvement of pain and function in both modalities, trapeziectomy with LRTI has more improvement in grip and pinch strength, but LRTI has higher complications.

Table 6. Summaries of surgical treatment options (*continued*)

Studies	Modalities	Conclusion
Raj et al., 2022(41)	Trapeziectomy, joint replacement	Effective improvement of pain and function in both modalities, joint replacement has a higher QDASH, key pinch, and VAS score than simple trapeziectomy, but the complication rate and reoperation rate are higher in joint replacement surgery.
Liukkonen et al., 2024(42)	Total joint arthroplasty	Effective improvement of pain and function in both modalities, grip and pinch strength improvements are better in joint replacement compared to simple trapeziectomy in long-term.
Seth et al., 2024(43)	Trapezium Implants: total joint replacement, hemiarthroplasties, interpositions with partial trapezial resections, and interpositions with total trapezial replacements	Effective improvement of pain and function in all modalities. Best improvement in pain: total joint replacement surgery. Best improvement in function: Interposition with partial trapezium resection surgery. The highest implant failure: total joint replacement surgery.

Abbreviations: PRP, platelet-rich plasma; LRTI, ligament reconstruction and tendon interposition; QDASH, Quick Disabilities of the Arm, Shoulder and Hand; VAS, visual analogue scale.

Surgical treatments on 1st CMC OA all have beneficial outcomes in improvement of pain and function. Autologous fat and PRP injection could be perform on early stages disease, it is the least invasive methods compared to others, but it might be ineffective in later stages. Although arthroscopic-assisted techniques are effective, the benefits of other conventional surgical treatments are unclear.

The 1st metacarpal extension osteotomy only has improvement in pain relief; the use of this treatment and outcome is limited, and it's less preferable than other interventions.
Arthrodesis even though it is effective in pain and function improvement and a greater key pinch strength than others, it has high revision surgery due to complication of nonunion, it is the least preferred surgical treatment.

Simple trapeziectomy is used as a comparison in several arthroplasty studies. It has effective improvement of pain and function, it has lower complications compared to other arthroplasty studies and arthrodesis, but the improvements are not superior to other arthroplasty interventions. Trapeziectomy with LRTI is the most popular surgical option among these interventions, it has better improvement in grip and pinch strength than trapeziectomy alone and fewer complications than arthrodesis.

1st CMC joint replacement surgery in general has a greater improvement in both pain and function, however, there is a risk of implant failure, and the reoperation rate of the surgery might be higher than other arthroplasty surgeries. Different types of trapezium implants also have different outcomes. Total joint replacement surgery has better pain relief than other implants. Interposition with partial trapezium resection surgery has better function improvement, but the implant failure rate in total joint replacement surgery is the highest.

4. Discussion

Effective treatments in pharmacological, physical, and surgical treatments each have their advantages and drawbacks. NSAIDs and corticosteroids have a huge number of studies and a long history of understanding in drug safety and effects. They are commonly used medications in healthcare and highly accessible, however, they are only effective in short-term use, which is not suitable for patients with persisting symptoms. Furthermore, long-term use of NSAIDs and corticosteroids may also cause serious side effects(50,51). Novel synergistic drugs, even though they show effectiveness in alleviating symptoms, the result of Wu's study could be questionable, due to other studies showing the ineffectiveness of DMARDs on hand OA. These drugs still need further research on long-term effects or more RCTs on hand OA, especially on 1st CMC joint(8,17–19).

Physical therapies are the safest treatment among the options, even though effectiveness varies; it is still worth trying out the types of physical therapy that the patient finds most suitable, and a combination of these physical therapies may have a more favorable outcome. Nevertheless, further stages of the disease might be insufficient with just pharmacological and/or physical therapies, therefore, surgical interventions could be introduced.

Different surgical interventions have risks and benefits. Autologous fat and platelet-rich plasma injections seem to be the least traumatic intervention among the surgical treatments, even though they seem to have effectiveness, but long-term results and frequency of reoperation have to be further studied. Currently, there is no perfect surgical treatment for 1st CMC OA; Implants might seem to have better outcomes in pain and function improvement, yet the costs of this surgery are also the highest among all these interventions, and it also requires specific training in the use of implants. Complications are also another factor that should be taken into consideration; risks of complications and risks of reoperation should be suitable to the patient's overall condition, such as age, finances, and labor environment.

In this review, there are other types of surgical procedures are not included, such as hemitrapeziectomy, trapeziectomy with suspensionplasty, trapeziectomy with ligament interposition alone, trapeziectomy with tendon interposition alone, and suture button suspension, etc. These procedures are not found in the PubMed database after applying the filters and keywords, therefore, this review could not establish a complete overview of all available treatment options' efficacy. Overall, further research on treating 1st CMC arthritis is needed in both conservative and surgical interventions; a comprehensive comparison of effectiveness between conservative and surgical treatment would be beneficial to understand the effectiveness differences of these treatments.

5. Conclusions and recommendations

In conclusion, supplements are ineffective, and most of the pharmacological interventions are ineffective, except oral non-steroidal anti-inflammatory drugs and corticosteroids; novel synergistic drugs might have potential as treatment. Physical therapies are also effective, even though in the long-term treatment might be less effective, it is still worth recommending before choosing to undergo surgeries.

Surgeries overall are an effective treatment for alleviating pain and improving function. Autologous fat and platelet-rich plasma injections are recommended to treat stage I to stage II first carpometacarpal arthritis, arthroplasty is recommended to treat stage II to stage IV first carpometacarpal arthritis. The least preferred surgery is arthrodesis due to complications; the most preferred surgery is trapeziectomy with ligament reconstruction and tendon interposition. Total joint arthroplasty has the potential to have a better outcome. Patients should be informed of the risks of interventions that could be provided, and the outcome expectations associated with them.

First carpometacarpal arthritis has various treatment options; based on this review, recommendations could be set on limited treatment options. Initial treatment is recommended to treat with either pharmacological and/or physical therapy. Pharmacological treatment could be

treated with oral non-steroidal anti-inflammatory drugs and corticosteroids; Physical therapy could be treated with splints, exercise, heat, and pulse electromagnetic field. When conservative measures are insufficient, surgical treatment could be recommended. Early stages could be treated with autologous fat and platelet-rich plasma injections; Later stages could be treated with simple trapeziectomy, trapeziectomy with ligament and tendon interposition, and joint replacement, depending on the patient's choices and the surgeon's availability to perform these surgeries. Table 7 summarizes all effective treatments in pain and function, with remarks on some interventions.

Table 7. Conclusions of all effective interventions

Interventions	Effectiveness in pain	Effectiveness in function	Remarks
Conservative			
Non-steroidal anti-inflammatory drugs	+	+	Short-term effectiveness.
Corticosteroids	+	+	Short-term effectiveness.
Novel synergistic drug	+	+	Require further studies.
Orthoses or splints	+	+	No effects in the short term.
Exercise-based	+	+	Immediate-term effectiveness.
Heat	+	+	Effective in both the short-term and long-term.
Pulse electromagnetic field	+	+	Effective in low frequency and short duration.

Table 7. Conclusions of all effective interventions(*continued*)

Interventions	Effectiveness in pain	Effectiveness in function	Remarks
Surgical			
Autologous fat and platelet-rich plasma injections	+	+	
Arthroscopic-assisted techniques	+	+	
First metacarpal extension osteotomy	+	-	
Arthrodesis	+	+ (Key pinch strength stronger)	High risk of reoperation, least preferred.
Simple trapeziectomy	+	+	
Trapeziectomy with ligament and tendon interposition	++	++	More complications than simple trapeziectomy.
Joint replacement(implants)	++	++	More complications than simple trapeziectomy.

+, effective; ++, more effective; -, ineffective. The effectiveness of these interventions does not reveal an actual comparison of effectiveness, since no studies were found during the literature search comparing surgical to conservative treatments. Among the effective interventions, only the first metacarpal extension osteotomy has shown ineffectiveness in function improvement.

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Annexes.