General

Outcome Comparison between Carpometacarpal Arthroplasty and Trapeziectomy in Patients with Carpometacarpal Osteoarthritis: A Systematic review

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Background

Osteoarthritis of the carpometacarpal (CMC) is considered a common musculoskeletal disorder. The treatment of carpometacarpal osteoarthritis could be either by conservative or surgical methods. surgical treatment, there are various alternatives, including trapeziectomy and arthroplasty. This study aims to perform a systematic review of the literature to determine the functional outcomes associated with trapeziectomy and arthroplasty in CMC arthritis.

Objectives

To determine the functional outcomes associated with trapeziectomy and arthroplasty in CMC arthritis patients.

Methods

A systematic review was conducted according to PRISMA guidelines and performed on August 2022 by one independent reviewer (author) using PubMed database, EBSCO Host, EMBASE, and ScienceDirect. The literature search will be based on *Patients, Intervention, Control, and Outcome* (PICO) criteria, as mentioned in the following: Patients with any carpometacarpal arthritis; with the intervention of using carpometacarpal arthroplasty as their method of surgery; control with trapeziectomy and primary outcome of functional outcome. Clinical outcomes using patient-reported outcome measures and complications were included. The quality of the included studies was evaluated with Cochrane risk-of-bias assessment tools. Quantitative analysis was performed by Review Manager 5.4.

Results

Three studies met the inclusion criteria for the systematic review. Both treatments resulted in significant improvements in functional scores. When matching patients according to preoperative function, patients receiving arthroplasty had better postoperative function (Quick DASH: trapeziectomy = 25.1, ARPE = 16.8).

Conclusion

This study showed that variable results of clinical outcomes improved after trapezeictomy and arthroplasty in patients with CMC arthritis. Evidence showed that arthroplasty allows for a better improvement in functional outcome.

INTRODUCTION

Osteoarthritis of the carpometacarpal (CMC) is considered a common musculoskeletal entity by which the age-adjusted prevalence rates for men and women with carpometacarpal joint osteoarthritis are 7% and 15%, respectively. Osteoarthritis of the CMC joint can result in discomfort, deformity, restricted range of motion, joint instability, and weakness, all of which can cause functional handicaps.[1-3]

Patients with CMC arthritis frequently experience a slow, insidious onset of steadily worsening discomfort at the CMC joint near the base of the thumb. They might talk about pain while squeezing and holding things, as well

as having trouble opening jars, turning keys, or clutching doorknobs. On examination, the thumb CMC joint frequently has a site of discomfort. If there is pain when compressing and rotating the thumb metacarpal, the axial grind test is positive.[2]

In general, the treatment of carpometacarpal osteoarthritis could be either by conservative or surgical methods. There are several conservative treatments for OA of the CMC joint. Conservative options include employing splints, slings, nonsteroidal anti-inflammatory medications, and cortisol injections, as well as compensating from other joints to minimize using the CMC joint (activity reduction). For surgical treatment, there are various alternatives, including trapeziectomy, interposition arthroplasty, ligament reconstruction, and fixation of flexor carpi radialis. One of the challenges in managing CMC joint osteoarthritis is the lack of guidance on which surgical intervention is more appropriate for a given clinical scenario. Moreover, due to the lack of consensus over which treatment is superior, the treatment for CMC joint osteoarthritis has often been guided by surgeon preference.[2]

A previous systematic review by Wajon et al. in 2015 found that there is no evidence that any single technique is superior in terms of pain and physical function; however, it was noted that the studies included were "not of high enough quality to provide conclusive evidence that the compared techniques provided equivalent outcomes."[4] A more up-to-date review by Lee et al. in 2021 compared joint replacement (JR) exclusively with LRTI and reported a superior clinical outcome for JR.[1]

Although the use of CMC joint arthroplasty is common in Europe, early systematic reviews have highlighted a lack of high-quality evidence to support its use.[5] Thumb CMCJ prosthetic total JR outcomes have now been published with fair to good long-term functional outcomes, and demonstrate encouraging clinical outcomes in comparative studies with resection arthroplasty at short–medium-term followup.

Patients with Eaton stage II–IV OA of the thumb CMC joint is the main target population for trapeziectomy. An osteotomy is a technique where the bone is removed or modified to alter the joint's anatomy. It alters the contact sites between the metacarpal and trapezium where cartilage is worn down and moves the thumb into a more extended and abducted position. This effort is targeted in order to lessen the possibility of subluxation.[3,6] However, as for osteotomy, only individuals with little articular cartilage wear on the volar surface can benefit from this operation, and younger, more active patients are more likely to benefit from this procedure.[7] Roman and colleagues found that patients with Eaton III/IV osteoarthritis undergoing trapeziectomy and suture suspension had increased thumb strength and ROM with complete relief of pain. Yao and colleagues similarly published reassuring data at both 2- and 5-year follow-ups without significant complications.[2]

The comparison of these two interventions, however, still needs to be investigated. We conducted a systematic review to establish the functional outcome of patients with carpometacarpal osteoarthritis treated by either trapeziectomy or arthroplasty.

METHOD

LITERATURE SEARCH AND SCREENING PROCESS

The systematic review will be conducted by adhering to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA). The review process starts with the literature search process in scientific databases, including PubMed, EBSCOHost, EMBASE, and ScienceDirect. The literature search will be based on *Patients, Intervention, Control, and Outcome* (PICO) criteria, as mentioned in the following: Patients with any carpometacarpal arthritis; with the intervention of using carpometacarpal arthroplasty as their method of surgery; control with trapeziectomy; and primary outcome of functional outcome.

The PICO criteria will then be translated into several queries and keywords as the following: **(Carpometacarpal Arthritis OR Thumb Arthritis OR Carpometacarpal Osteoarthritis OR Thumb Osteoarthritis) AND (Trapeziectomy OR Ligament Reconstruction) AND Carpometacarpal Arthroplasty).** MeSH-Terms will be used if available in the mentioned databases. The literature will then be selected against the predetermined inclusion and exclusion criteria. A study is included with the following criteria: Studies on the comparison of carpometacarpal arthroplasty and trapeziectomy on carpometacarpal arthritis, published within the last 10 years (2012–2022), written or available in English, with original studies such as retrospective or prospective clinical studies. The study will be excluded if it is a review article, letters, or correspondence and there is no complete data to retrieve.

RISK-OF-BIAS ASSESSMENT

The qualities of the studies included were assessed with Cochrane risk-of-bias assessment tools. These evaluations were conducted by reviewers. Each study will be assessed as "low-risk," "high-risk," or "unclear risk" based on seven evidence-based domains. The domains are: "Random sequence generation (selection bias)." "Allocation concealment (selection bias)," "blinding of participants and personnel (performance bias)," "blinding of outcome assessment (detection bias)," "incomplete outcome data (attrition bias)," "selective reporting (reporting bias)," "other bias."

DATA EXTRACTION

The data extraction will be conducted to summarize the included studies' characteristics, such as the year of publication, trial location, trial design, intervention used on the study, and cancer population used in the study. The outcomes of the included studies are also summarized as seen in **Table 1**.

Table 1. PICO Criteria of the Study

Patients	Patients with any carpometacarpal arthritis including carpometacarpal osteoarthtritis
Intervention	Carpometacarpal arthoplasty
Control	Carpometacarpal trapeziectomy
Outcome	Functional outcome

RESULT

LITERATURE SEARCH AND STUDY CHARACTERISTICS

The present literature search was planned, conducted, and reported according to the PRISMA guidelines. On July 18, 2022, we searched the literature on several databases such as PubMed, ScienceDirect, EMBASE, and EBSCOHost with the following keywords: (Carpometacarpal Arthritis OR Thumb Arthritis OR Carpometacarpal Osteoarthritis OR Thumb Osteoarthritis) AND (Trapeziectomy OR Ligament Reconstruction) AND Carpometacarpal Arthroplasty, so that the literature obtained is in accordance with the PICO that has been determined and described previously. From the search results of four databases according to the specified keywords, we obtained 372 study results with the following details: 113 studies from PubMed, 97 studies from ScienceDirect, 70 studies from EBSCOHost, and 92 studies from EMBASE. Prior to screening the literature obtained, there were only 14 studies that met the PICO criteria for the title and only 13 studies that met the inclusion criteria, including; Adult patients >18 years who underwent surgery with trapeziectomy and carpometacarpal arthroplasty. Eleven studies were excluded due to duplication and remaining 3 studies were included for systematic review. (figure 1)

The included studies were published between the years 2012 and 2022. There are a total of 155 subjects included from all of the studies. Most of the study designs used retrospective studies, but there is one study that used prospective study. The intervention and the control procedures for each study were slightly similar. The procedure used in the control group was carpometacarpal trapeziectomy and the procedure used in the intervention group was carpometacarpal arthroplasty. The average duration of followup for each study has a fairly different time range, with the average duration of the study including 12 months, 20 months, and 40 months. (Table 2)

RISK-OF-BIAS ASSESSMENT

Of all the included studies, all studies have a low bias risk regarding confounding bias. (Figure 2) One study had different followup time and the other had superficial inclusion and exclusion criteria; therefore, there was a high bias risk regarding selection bias. All three studies have the risk of bias in the selection of participants into the study due to the design of the studies (retrospective studies). Since all studies did not describe additional interventions that occurred or were administered to patients, the possibility of bias due to deviation from the intended intervention is low. All studies have a low risk of bias from missing data because no imputation of missing data is reported. All studies reported their results based on their proposed design and the measurement of the outcome is well defined; thus, the risk of having a reporting bias and bias in the measurement of the outcome is low.

DISCUSSION

The goal of CMC arthritis thumb surgery is to provide good support for the base of the first metacarpal bone, in addition to improving the patient's grip strength and maintaining the range of motion of the bone. Surgeons have several surgical options to treat CMC arthritis, one of which is trapeziectomy and arthroplasty.[1] It has been hypothesized that the management of CMC arthritis using arthroplasty can provide better postoperative function by maintaining range of motion and improving bone quality as well as preventing shortening of the thumb.[1] Of the 14 studies that had titles that matched the topic discussed, only 3 studies met the inclusion criteria, of which 2 studies were retrospective studies and the remaining 1 study was a prospective studies.

Of the three studies reviewed, the DASH score was the outcome discussed by all studies. Studies by Johnathan et al[8] and Meghan et al[9] showed that the DASH score of patients with arthroplasty was lower than the DASH score of patients with trapeziectomy.[8,9] Whereas only the study by Maru et al[2] showed a lower DASH score in patients with trapeziectomy than in patients with artoplasty.[2] This indicated that the functional outcome, one of which was assessed by the DASH score, had a better result in patients with arthroplasty compared to trapeziectomy. This finding is supported by a meta-analysis study by Raj et al where QDASH scores were significantly lower in patients with arthoplasty/JR than in patients with trapeziectomy (5 studies, $p = 0.0004$).[10]

The first study was a retrospective study conducted by Maru et al in 2012.[2] In this study, the functional outcomes assessed were the DASH score and the SF-36 score, while the pain outcome was evaluated by the VAS score and the satisfaction outcome was assessed using a 5-point scale.[2] The results of the study stated that patients with trapeziectomy had lower DASH scores than patients with arthroplasty ($p = 0.001$), which could imply that the functional outcome of trapeziectomy patients was better than those using arthroplasty, although the SF score of 36 in the second group did not have a significant difference ($p = 0.2$). In contrast to the functional outcome, the pain outcome as measured by the VAS scale showed that arthroplasty had a better score with a VAS score of 8, compared with trapeziectomy with a VAS score of 9.

An osteotomy or fusion surgery is recommended depending on the severity of the affected joint.[11] Although there are numerous benefits, there are still potential risks and disadvantages of the trapeziectomy procedure. This is because the excision of the trapezium can result in the loss

Table 2. Summary of the Study's Data

Author, year	Study design	No. of patients	Mean follow up duration (month)	Sample population	Outcome measurement	Outcome results
Maru et al, 2012	Retrospective study	33 patients (18 thumbs had trapeziectomy vs. 18 had arthroplasty	20 months	33 patients (36 thumbs) with primary osteoarthritis at the thumb base who were treated between April 2004 and April 2009 in a single center. Two upper limb surgeons performed for this disorder, while one performed a trapeziectomy	DASH and Short Form 36 (SF-36) scores at a mean of 20 months. Pain severity was assessed using VAS, and the level of patient satisfaction was assessed using a 50 point scale	The mean DASH score for the trapeziectomy group was 27 (95% CI 22–29), and 35 (95% CI 31–38; $p = 0.001$) in the Pi2 arthroplasty group. There was no difference in the SF-36 scores between the two groups. The mean preoperative VAS was 9(8–10) for trapeziectomy and 9(8–10) for Pi2 arthroplasty group vs. 4(3–5) and 6(5–6). 6 of 18 patient in Pi2 group had multiple operations (>3) for a dislocated or subluxed implant, 1 patient had 3 revisions for dislocation and implant was removed, 1 patient had superficial wound infection.
Johnathan et al, 2017	Retrospective study	46 patients with trapeziectomy vs. 46 patients with arthroplasty	40.8 months (trapeziectomy) vs. 24 months (arthroplasty)	Patients were treated with either trapeziectomy or ARPE thumb CMCJ arthroplasty; a single surgeon practiced between June 2010 and June 2014. All patients presenting with pan-trapezial arthritis were excluded. Prior to January 2011, the senior author offered trapeziectomy for patients who failed conservative treatment for stage II and III arthritis. After January 2011, patients were given an option of trapeziectomy or CMCJ arthroplasty with the ARPE implant	Quick DASH score, radiological shortening and complication rates	75 trapeziectomies vs. 110 ARPE arthroplasties were performed during the study period. ARPE arthroplasty showed better function (Quick DASH: trapeziectomy = 25.1, ARPE = 16.8). Patient satisfaction (trapeziectomy = 7.8/10, vs. ARPE = 8.7/10) The patient would have undergone the same treatment again (trapeziectomy = 76% vs. ARPE = 89%). ARPE also resulted in less thumb shortening. ARPE arthroplasty is associated with a higher complication rate, with 14% of patients requiring further surgery at a mean of 2 years followup (95% implant survival).
Meghan et al, 2021	Prospective study	7 patients with trapeziectomy vs. 23 patients with arthroplasty	12 months	A total of 25 hands of 25 patients (4 males, 21 females; mean age: 63.6 ± 5.8 years; range, 54 to 76 years). All patients underwent trapeziectomy and ligament reconstruction and suspensionplasty procedure due to the diagnosis of thumb CMC joint osteoarthritis	Patients' Disabilities of the Arm, Shoulder, and Hand (DASH) and Wong-Baker pain scale scores were recorded with standardized, validated survey instruments	The mean age was similar At 61.4 (48–72) years and 65.7 (56–78) years for the study and control groups, respectively. The DASH scores dropped by 61.8% in the study group compared with 38.8% in the control group (<0.01), whereas pain decreased 86.0% and 69.8%, respectively (P <.01). Strength and range of motion improvements were similar between the groups. The subsidence of the joint space was 1% in the study group compared with 18.4% in the control group. There were no surgical complications in either group

of integrity of the scaphotrapezium-trapezoidal ligament. Initially, it was feared that carpal instability would occur after surgery,[12,13] but a study conducted by Heren et al.[6] countered these concerns 3 years after the patient had a trapeziectomy.[6]

However, a study published by Wajon et al. in 2005 concluded that side effects were more common in patients with arthroplasty procedures,[4] which was approximately 11% more and this was also supported by the study by Maru et al. where the functional outcome in patients with arthroplasty scored no better than patients with trapeziectomy. Several researchers agree that there is a high probability of reducing the morbidity of the trapeziectomy procedure. However, to obtain a good outcome, patient selection and realistic patient expectations are required. There are several conditions that exclude this procedure, one of which is a young patient who is still active and requires preservation of a strong grip and pinch force to work or do daily living activites.[8,9]

Another study that also met the inclusion criteria of this systematic review was the study conducted by Johnathan et al.[6] This study compared patients with CMC osteoarthritis who underwent a trapeziectomy procedure with ARPE arthroplasty.[6] The outcomes assessed in this study are almost the same as those in Maru et al.'s study, which are functional and satisfaction outcomes. This study's results were different from the study by Maru et al where patients who were operated on by arthroplasty procedures had more favorable results in functional and satisfaction outcomes than patients with trapeziectomy. The results of this study show that the second method used is an effective surgical method for CMC osteoarthritis. However, patients with arthroplasty have slightly better and significantly better satisfaction and functional outcomes than patients with trapeziectomy, this is because the arthroplasty procedure is better at maintaining the height of the trapezoid. Recent studies using this type of ARPE implant show the percentage of survival rates for 10 years between 80 and 87%.[13] This is in line with one study conducted by Apard et al. with a survival rate of 79%.[5] The study by Martin-Ferrero et al. showed a higher rate of about 94% at the 10-year survival rate.[14] The study by Chakrabarti et al. also showed good results of around 86% at the 16-year survival rate, and even the survival rate still touched 74% at the 20-year followup.[15] The study showed that patients who underwent arthroplasty using ARPE implants had a reasonably high survival rate. Two major complications reported in the literature are dislocation and loosening of implants, one of which is a study conducted by Brutus et al.[16]

Compared with trapeziectomy, arthroplasty procedure has a better outcome, where there was a significant reduction in pain outcomes and disability outcomes of patients operated on by the arthroplasty method compared with patients operated by trapeziectomy.[8] In this study, the intervention group consisted of patients who underwent surgery with an arthroplasty procedure using a meniscal allograph, while the control group consisted of patients who underwent surgery with a trapeziectomy procedure. Disability outcomes were assessed by DASH scores, where patients with arthroplasty had significantly better postoperative DASH scores than patients with trapeziectomy, as well as pain outcomes. However, the author mentioned that the risk of complications and further surgeries is greater in the arthroplasty group. Complications from trapeziectomy and arthroplasty procedures can range from 20 to 40%.[6] The limitation of this systematic review is that the articles obtained and according to the inclusion criteria are not so many, only about 3 articles, this is because it is pretty difficult to find articles that only compare the two methods, many of the studies obtained, not only comparing the two methods but comparing the other methods too. In addition, from the four articles, the arthroplasty method used is not uniform so the comparison of the assessed outcomes can be different.

CONCLUSION

This study showed that variable results of clinical outcomes improved after trapeziectomy and arthroplasty in patients with CMC arthritis. Most evidence shows that arthroplasty allows a better improvement in functional outcomes.

FIGURE LEGENDS

Figure 1. Article selection for the systematic review

Figure 2. Risk of bias summary for preclinical studies

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