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Surgery for thumb (trapeziometacarpal joint) osteoarthritis (Review)

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Surgery for thumb (trapeziometacarpal joint) osteoarthritis.
Cochrane Database of Systematic Reviews 2015, Issue 2. Art. No.: CD004631.
DOI: 10.1002/14651858.CD004631.pub4.

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[Intervention Review]

Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Anne Wajon[1], Toby Vinycomb[2], Emma Carr[3], Ian Edmunds[4], Louise Ada[5]

[1]Macquarie Hand Therapy, Macquarie University Clinic, Macquarie University, Australia. [2]Department of Surgery (MMC), Monash University, Melbourne, Australia. [3]Pacific Hand Therapy Services, Dee Why, Australia. [4]Hornsby Hand Centre, Hornsby, Australia. [5]School of Physiotherapy, University of Sydney, Lidcombe, Australia

Contact address: Anne Wajon, Macquarie Hand Therapy, Macquarie University Clinic, 2 Technology Place, Macquarie University, New South Wales, 2109, Australia. anne@wajon.com.au.

Editorial group: Cochrane Musculoskeletal Group.
Publication status and date: Edited (no change to conclusions), published in Issue 3, 2017.

Citation: Wajon A, Vinycomb T, Carr E, Edmunds I, Ada L. Surgery for thumb (trapeziometacarpal joint) osteoarthritis. *Cochrane Database of Systematic Reviews* 2015, Issue 2. Art. No.: CD004631. DOI: 10.1002/14651858.CD004631.pub4.

ABSTRACT

Background

Surgery is used to treat persistent pain and dysfunction at the base of the thumb when conservative management, such as splinting, or medical management, such as oral analgesics, is no longer adequate in reducing disability and pain. This is an update of a Cochrane Review first published in 2005.

Objectives

To assess the effects of different surgical techniques for trapeziometacarpal (thumb) osteoarthritis.

Search methods

We searched the following sources up to 08 August 2013: CENTRAL (*The Cochrane Library* 2013, Issue 8), MEDLINE (1950 to August 2013), EMBASE (1974 to August 2013), CINAHL (1982 to August 2013), Clinicaltrials.gov (to August 2013) and World Health Organization (WHO) Clinical Trials Portal (to August 2013).

Selection criteria

Randomised controlled trials (RCTs) or quasi-RCTs where the intervention was surgery for people with thumb osteoarthritis. Outcomes were pain, physical function, quality of life, patient global assessment, adverse events, treatment failure or trapeziometacarpal joint imaging.

Data collection and analysis

We used standard methodological procedures expected by the Cochrane Collaboration. Two review authors independently screened and included studies according to the inclusion criteria, assessed the risk of bias and extracted data, including adverse events.

Main results

We included 11 studies with 670 participants. Seven surgical procedures were identified (trapeziectomy with ligament reconstruction and tendon interposition (LRTI), trapeziectomy, trapeziectomy with ligament reconstruction, trapeziectomy with interpositional arthroplasty (IA), Artelon joint resurfacing, arthrodesis and Swanson joint replacement). We did not find any studies that compared surgery with sham surgery or surgery with non-surgical interventions.

Most included studies had an unclear risk of most biases which raises doubt about the results. No procedure demonstrated any superiority over another in terms of pain, physical function, quality of life, patient global assessment, adverse events, treatment failure (re-operation)

or trapeziometacarpal joint imaging. One study demonstrated a difference in adverse events (mild-moderate swelling) between Artelon joint replacement and trapeziectomy with tendon interposition. However, the quality of evidence was very low due to a high risk of bias and imprecision of results.

Low quality evidence suggests trapeziectomy with LRTI may not provide additional benefits or result in more adverse events over trapeziectomy alone. Mean pain (three studies, 162 participants) was 26 mm on a 0 to 100 mm VAS (0 is no pain) for trapeziectomy alone, trapeziectomy with LRTI reduced pain by a mean of 2.8 mm (95% confidence interval (CI) -9.8 to 4.2) or an absolute reduction of 3% (-10% to 4%). Mean physical function (three studies, 211 participants) was 31.1 points on a 0 to 100 point scale (0 is best physical function, or no disability) with trapeziectomy alone, trapeziectomy with LRTI resulted in sightly lower function scores (standardised mean difference 0.1, 95% CI -0.30 to 0.32), an equivalent to a worsening of 0.2 points (95% CI -5.8 to 6.1) on a 0 to 100 point scale (absolute decrease in function 0.03% (-0.83% to 0.88%)). Low quality evidence from four studies (328 participants) indicates that the mean number of adverse events was 10 per 100 participants for trapeziectomy alone, and 19 events per 100 participants for trapeziectomy with LRTI (RR 1.89, 95% CI 0.96 to 3.73) or an absolute risk increase of 9% (95% CI 0% to 28%). Low quality evidence from one study (42 participants) indicates that the mean scapho-metacarpal distance was 2.3 mm for the trapeziectomy alone group, trapeziectomy with LRTI resulted in a mean of 0.1 mm less distance (95% CI -0.81 to 0.61). None of the included trials reported global assessment, quality of life, and revision or re-operation rates.

Low-quality evidence from two small studies (51 participants) indicated that trapeziectomy with LRTI may not improve function or slow joint degeneration, or produce additional adverse events over trapeziectomy and ligament reconstruction.

We are uncertain of the benefits or harms of other surgical techniques due to the mostly low quality evidence from single studies and the low reporting rates of key outcomes. There was insufficient evidence to assess if trapeziectomy with LRTI had additional benefit over arthrodesis or trapeziectomy with IA. There was also insufficient evidence to assess if trapeziectomy with IA had any additional benefit over the Artelon joint implant, the Swanson joint replacement or trapeziectomy alone.

Authors' conclusions

We did not identify any studies that compared surgery to sham surgery or to non-operative treatments. We were unable to demonstrate that any technique confers a benefit over another technique in terms of pain and physical function. Furthermore, the included studies were not of high enough quality to provide conclusive evidence that the compared techniques provided equivalent outcomes.

PLAIN LANGUAGE SUMMARY

Surgery for osteoarthritis of the thumb

Background

Osteoarthritis is a disease of the joints, such as your knee or hip. Osteoarthritis at the base of the thumb (or trapeziometacarpal joint) may cause pain, stiffness and weakness in the thumb. This can affect how well the thumb moves, how strong a person's grip is, and how well a person can do routine things at home or at work. There are many types of surgery for the base of the thumb but they all have the same aim: to reduce pain and increase function (or reduce disability).

Study characteristics

Researchers from the Cochrane Collaboration examined the evidence for surgical treatment for osteoarthritis of the thumb. After searching for all relevant studies up to 8 August 2013, we included 11 studies (670 participants). Most participants were women with osteoarthritis who had inadequate relief with conservative measures, such as splinting, or oral analgesia such as paracetamol.

The most common technique used involved the removal of the trapezium bone at the base of the thumb (trapeziectomy) plus reconstruction of the ligament that holds the bones between the thumb and index finger together (ligament reconstruction) and filling the space left behind by the removed trapezium with spare tendon from the forearm to support the thumb (interpositional arthroplasty (IA); or commonly called 'trapeziectomy with LRTI'). Four studies (421 participants) compared this to the second most common procedure, trapeziectomy alone. Other studies compared trapeziectomy with LRTI to joint resurfacing (two studies, 113 people), arthrodesis (joint fusion; one study, 40 participants) or joint replacement (one study, 26 people). No studies included sham surgery as a comparison.

We chose trapeziectomy with LRTI versus trapeziectomy alone as our main comparison as these are the two most commonly performed procedures and were represented in the most studies (four studies).

Key results:

Trapeziectomy with LRTI versus trapeziectomy alone

Pain on a scale of 0 to 100 mm (lower scores mean reduced pain):

- People who underwent trapeziectomy with LRTI rated their pain to be 3 mm lower (10 mm lower to 4 mm higher) at three to 54 months of follow-up (3% absolute improvement) compared with people who had trapeziectomy alone;

- People who underwent trapeziectomy with LRTI rated their pain as 30 mm;

- People who underwent trapeziectomy alone rated their pain as 26 mm.

Physical function (0 to 100 point score, lower means less disability):

- People who underwent trapeziectomy with LRTI rated their disability as 0.03 points higher (0.83 points lower to 0.88 points higher) at seven to 97 months follow-up compared to people who had trapeziectomy alone;

- People who underwent trapeziectomy with LRTI rated their disability as 31 points;

- People who underwent trapeziectomy alone also rated their disability as 31 points.

Side effects

- Nine more people out of 100 (0 to 29 more people) who had trapeziectomy with LRTI experienced side effects (9% absolute increase in adverse events), compared with people who had trapeziectomy alone;

- 19 out of 100 people who had trapeziectomy with LRTI had an adverse event;

- 10 out of 100 who underwent trapeziectomy alone experienced an adverse event.

Single studies reported comparison between less commonly performed techniques that are reported in the main article.

Quality of the evidence

There is low-quality evidence that in people with thumb osteoarthritis, trapeziectomy with LRTI may not improve pain or function, or have less side effects than trapeziectomy alone. There was insufficient evidence to assess if trapeziectomy with LRTI had additional benefit over trapeziectomy with ligament reconstruction, arthrodesis or trapeziectomy with IA. There was also insufficient evidence to assess if trapeziectomy with IA had any additional benefit over the Artelon joint implant, the Swanson joint replacement or trapeziectomy alone.

Further research is likely to change the estimates of these results.

We are uncertain if any surgery has benefits compared to no surgery, non-surgical therapies or sham surgery as no studies were found assessing these comparisons.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON [Explanation]

Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

Patient or population: Patients with thumb (trapeziometacarpal joint) osteoarthritis
Settings: Hospital
Intervention: Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI)
Comparison: Trapeziectomy (T)

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Trapeziectomy (T)	Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI)				
Pain 100mm VAS . Scale from: 0 to 100. Follow-up: 3 to 54 months	The mean pain in the control groups was **26 mm**	The mean pain in the intervention groups was **2.8 lower** (9.8 lower to 4.2 higher)		162 (3 studies)	⊕⊕◯◯ **low**[1,2,3,4]	Absolute change -3% (-10% to 4%); Relative change -4% (-13% to 6%)[5].
Physical function DASH Score. Scale from: 0 to 100. Follow-up: 7 to 97 months	The mean physical function in the control groups was **31 points**	The mean physical function in the intervention groups was **0.01 standard deviations higher** (0.30 lower to 0.32 higher) This translates to an absolute mean increase of 0.03 (-0.83 to 0.88) points compared to control using a 0 to 100 point scale[7]		211 (3 studies)	⊕⊕◯◯ **low**[1,2,4,6]	SMD 0.01 (-0.30 to 0.32); Absolute change 0.03% (-0.83% to 0.88%) ; Relative change 0.05% (-1.56% to 1.66%)[7].

Quality of life - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Global assessment - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Adverse events Complications reported Follow-up: 7 to 54 months	**Moderate** **10 per 100**	**19 per 100** (10 to 39)	**RR 1.81** (0.96 to 3.73)	328 (4 studies)	⊕⊕◯◯ **low**[1,3,4,6,8]	Absolute change of 5% (-1% to 11%) Relative change 89% (-4% to 273%)
Treatment failure - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Trapeziometacarpal joint imaging Scapho-metacarpal distance Follow-up: 7 to 29 months	The mean trapeziometacarpal joint imaging in the control groups was **2.3 mm**	The mean trapeziometacarpal joint imaging in the intervention groups was **0.1 lower** (0.81 lower to 0.61 higher)		42 (1 study)	⊕⊕◯◯ **low**[1,4]	Absolute and relative change cannot be calculated[9].

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio.

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Belcher 2000: Unclear performance bias; unclear detection bias; unclear attrition bias; unclear reporting bias.
[2] De Smet 2004: Unclear selection bias; unclear performance bias; unclear detection bias; unclear attrition bias; unclear reporting bias.
[3] Field 2007: Unclear selection bias; unclear performance bias; unclear detection bias; unclear reporting bias.
[4] Less than 300 total participants (imprecision).

[5] Relative change calculated using the mean from control group in Field 2007 (mean 76 mm).
[6] Salem 2012: Unclear selection bias; unclear performance bias; high risk of selection bias; unclear reporting bias.
[7] Absolute and relative change calculated using the mean and SD from the control group in Salem 2012 (DASH score, mean 53 points; SD 2.75 points).
[8] Gangopadhyay 2012: Unclear performance bias; unclear reporting bias.
[9] Absolute change cannot be calculated as there is no scale for trapeziometacarpal joint space imaging. Relative change cannot be calculated as there is no baseline mean in any control groups as this space is created during the surgery.

BACKGROUND

Description of the condition

Osteoarthritis at the base of the thumb is a common problem (Armstrong 1994), especially in women in the fifth to seventh decades of life (Swigart 1999). A cohort study that investigated the prevalence of hand osteoarthritis revealed that 32% of people over the age of 50 years had radiological evidence of trapeziometacarpal joint osteoarthritis (Haugen 2011). Another study indicated that, in a population aged over 80 years old, radiographic evidence of trapeziometacarpal osteoarthritis is as high as 91% (Sodha 2005). Despite a very high prevalence of radiographic osteoarthritis, particularly in the elderly community, the presence of radiological findings does not correlate well with symptoms (Eaton 1987). For example, a person with mild or moderate radiographic trapeziometacarpal osteoarthritis may suffer little or no symptoms. On the other hand, a person with the same radiological findings may experience a high degree of pain and disability. As a result, trapeziometacarpal osteoarthritis is frequently treated based on symptoms rather than radiological investigation.

For many people, symptoms are minimal and intervention is not required. For others, pain, stiffness and weakness cause considerable interference to physical function (Menon 1995). A variety of occupations, domestic tasks, hobbies and sports can aggravate symptoms at the base of the thumb (Wajon 2000), especially if they involve heavy of repetitive pinch and gripping activities.

Palliative treatments (e.g. education, splints, non-narcotic pain medication, thermal modalities and exercise) can be helpful for some people. They aim to decrease pain, increase strength and improve physical function (Wajon 2005a). However, for some people symptom relief with non-operative intervention is inadequate, short-lived or both. Those with persistent pain, weakness or instability, which interferes with performance of daily activities, may decide to consider their surgical options.

Description of the intervention

Since the severity of symptoms of osteoarthritis at the trapeziometacarpal joint does not necessarily correspond with the radiographic stage of the disease, the decision to proceed with surgery is determined by the extent to which pain and loss of function interfere with activities of daily living (Glickel 2001). Other considerations include the patient's age and specific functional demands.

In the past, treatment choice was focused around the use of the Eaton and Littler staging (Eaton 1973) of trapeziometacarpal joint osteoarthritis. However, there is now a much greater focus on 'treating the patient not the x-ray' (Glickel 2001) and the decision to perform an operation is based on a person's symptoms and disability.

In this Cochrane Review, we report a number of surgical techniques. A brief explanation of the procedures is as follows:

- Trapeziectomy: removal of the trapezium bone (Gervis 1949);
- Trapeziectomy with ligament reconstruction: trapeziectomy as above plus reconstruction of the ligament between the base of the first and second metacarpal bones of the hand using a tendon harvested from the forearm (Eaton 1973);
- Trapeziectomy with tendon interposition: trapeziectomy as above plus interposition of a ball of tendon harvested from the forearm into the space left by the trapezium (Froimson 1970);
- Trapeziectomy with ligament reconstruction and tendon interposition (LRTI): trapeziectomy as above plus LRTI as above using the same tendon harvested from the forearm (Burton 1986);
- Metacarpal resection: a wedge excision of bone from the first metacarpal (Dell 1978);
- Artelon joint resurfacing: interposition of a T-shaped implant to replace the surface between the first metacarpal and trapezium (Nilsson 2005);
- Swanson joint replacement: trapeziectomy as described above plus a T-shaped implant with the long arm into the first metacarpal and the two short arms filling the space left after excision of the trapezium (Swanson 1972).

How the intervention might work

In the last 70 years there have been a plethora of surgical techniques to treat trapeziometacarpal osteoarthritis. Today, the choice of surgical procedure is likely to be influenced by the severity of a person's symptoms and their functional demands, and the extent and severity of their arthritis on x-rays. Available techniques include metacarpal osteotomy, trapeziometacarpal arthrodesis, trapeziectomy (with or without LRTI or implant), interpositional arthroplasty (IA) or trapeziometacarpal joint replacement.

Metacarpal osteotomy has been reported to provide lasting pain relief, correct any adduction contracture and restore strength (Hobby 1998). Trapeziometacarpal arthrodesis is the procedure of choice for younger, high-demand people with arthritis confined to the trapeziometacarpal joint, including those with post-traumatic arthritis, because of the stability and increased strength achieved (Fulton 2001). However, arthrodesis results in significant loss of motion at the base of the thumb and has been associated with compensatory hyperextension at the metacarpophalangeal joint (Bamberger 1992).

In 1949, Gervis introduced the simple trapeziectomy as a 'cure' to trapeziometacarpal osteoarthritis (Gervis 1949). It quickly fell out of favour due the perceived risk of pain and weakness caused by proximal migration of the first metacarpal. This was thought to cause abutment between the thumb metacarpal and scaphoid with loss of length of the thumb ray (Davis 2004). A variety of procedures have been designed to address these problems. Trapeziec-

tomy with LRTI (Burton 1986) was found to improve strength and restore web space, however the potential for recession of the metacarpal and instability at the pseudoarthrosis site remains a concern (Kuschner 1996). A more recent proposal has been to suspend the thumb metacarpal using Kirschner wires for six weeks postoperatively (Jones 2001). This would then allow a haematoma to develop, fibrose and then maintain metacarpal height. Alternative interpositional arthroplasties include procedures which excise either all or part of the trapezium and interpose the space with materials such as silicone (O'Leary 2002), allograft (Kokkalis 2009; Trumble 2000; Schmidt 2000), polyurethaneurea (Artelon) (Nilsson 2005), polypropylene (Marlex) (Muermans 1998), titanium (Swanson 1972) or pyrocarbon (Ardouin 2011).

Prosthesis are also available and include the ball-and-socket type arthroplasty (Hannula 1999) and the Avanta joint resurfacing type arthroplasty (http://www.avanta.org/hand.htm), both of which can be either cemented (e.g. de la Caffinière) or non-cemented (e.g. Ledoux) (Wachtl 1998). Replacement of the degenerative articular joint surfaces with prostheses has the potential to reproduce normal kinematics and stability at the joint in the presence of intact ligaments (Uchiyama 1999), but unfortunately these prostheses have also been reported to subside, loosen, dislocate and break (Linscheid 2000).

Until recently, trapeziectomy with LRTI has been the gold-standard procedure for low-demand elderly patients with more advanced disease. However, more recent studies support the resurgence of trapeziectomy alone as the preferred technique due to its good long-term results (Gangopadhyay 2012; Raven 2007).

Why it is important to do this review

Considering the variety of surgical techniques available for the treatment of trapeziometacarpal osteoarthritis, there remains uncertainty regarding which technique provides superior outcomes (Hartigan 2001).

OBJECTIVES

Our primary objectives were to assess:

- the effect of surgery on reducing pain as well as improving physical function and quality of life in people with trapeziometacarpal osteoarthritis;
- to report on the treatment failure rate as well as the number and types of adverse events;
- the variation between surgeries for trapeziometacarpal joint osteoarthritis with regards to trapeziometacarpal joint imaging.

Secondary objectives were to assess improvements in range of motion and strength as a result of surgery for trapeziometacarpal osteoarthritis.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs), quasi-randomised and controlled studies. We included all studies that reported clinically relevant outcomes regardless of methodological quality. We assessed allocation concealment (Schulz 1995), blinding (of participants, investigators and outcome assessment), intention-to-treat analysis (Egger 1997) and completeness of follow-up for all studies, but we did not use these as inclusion or exclusion criteria.

Types of participants

We considered studies which included participants of any age and gender with a clinical diagnosis of Stage I-IV trapeziometacarpal osteoarthritis. We categorised staging of osteoarthritis according to the system of Eaton 1973, p.1660:

- Stage I
  - articular contours normal;
  - slight widening of the joint space.
- Stage II
  - slight narrowing of the joint space;
  - minimal sclerotic changes;
  - joint debris < 2 mm diameter.
- Stage III
  - joint space markedly narrowed or obliterated;
  - cystic changes, sclerotic bone, varying degrees of dorsal subluxation;
  - joint debris > 2 mm in diameter;
  - scaphotrapezial joint appear normal.
- Stage IV
  - complete deterioration of trapeziometacarpal joint, as in Stage III;
  - scaphotrapezial joint narrowed with sclerotic and cystic changes apparent.

Although we envisaged that some studies would include participants who also underwent surgery to the metacarpophalangeal joint, we did not identify any such studies. If we had identified such studies, they would have formed a subgroup of the main surgical procedure performed at the trapeziometacarpal joint.

Types of interventions

We included studies that evaluated the effect of surgery to the trapeziometacarpal joint, such as:

- metacarpal osteotomy;
- trapeziometacarpal arthrodesis;
- trapeziectomy;
- trapeziectomy with ligament reconstruction;
- trapeziectomy with LRTI;
- trapeziectomy with IA;
- trapeziometacarpal joint replacement;
- Artelon joint resurfacing;
- sham surgery (where patients are anaesthetised and the incisions made but the operation not undertaken).

We included studies that compared at least two surgical techniques for in the management of trapeziometacarpal osteoarthritis. We excluded studies that used non-surgical interventions (e.g. splinting). We planned to include studies that compared sham procedures with surgery if available.

Types of outcome measures

Outcome assessment in osteoarthritis requires reliable, valid and responsive measurement techniques (Bellamy 1999). The OMERACT III conference in 1996 recommended a core set of outcome measures for use in trials of osteoarthritis (Bellamy 1997). These include: pain, physical function, patient global assessment and joint imaging techniques for studies of one year or greater (Bellamy 1997a; Brooks 2001). Measurements of range of motion and grip or pinch strength were also included. We recorded adverse events of surgery and postoperative management where available.

Major outcomes

We included six major outcomes when analysing the results of this review and reported these results in the 'Summary of findings' table.

Pain

We performed analysis of the effect of surgery on pain for continuous variables. The continuous variable of pain was measured in centimetres on a visual analogue scale (VAS). If studies reported the presence or absence of pain, we performed the analysis for dichotomous variables. We only included pain reported using the VAS in the 'Summary of Findings' table.

Physical function

We performed analysis of the effect of surgery on physical function for continuous variables. The continuous variable of physical function was measured using functional scales of upper limb activities which were normalised. Examples of functional scales are the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire (Hunsaker 2002; Solway 2002), Patient Rated Wrist Evaluation (MacDermid 2007), Sollerman Test of Hand Function (Sollerman 1995) and the Jebsen Hand Function Test (Jebsen 1969). Other scales which reported physical function as good-excellent were performed for dichotomous variables (e.g. the Buck-Gramcko score). We preferentially used continuous variables (in the order listed above) before considering the dichotomous variables for reporting in the 'Summary of findings' tables.

Quality of life

We performed this analysis of using subjective 'Quality of Life' questionnaires. Examples of patient global assessment measures are the Short Form-36 Health Survey (SF-36). If studies in comparison reported more than one patient global assessment, we preferentially used scores that evaluated a wider number of outcomes.

Patient global assessment

We performed analysis of the effect of surgery on patient global assessment for dichotomous variables. Examples include dichotomous patient satisfaction or whether the patient would, given their experience, have the operation again.

Adverse events

We performed analysis of any adverse events resulting from trapeziometacarpal surgery for dichotomous variables. Examples of adverse events are the presence of Complex Regional Pain Syndrome (CRPS) (Type I), non-union, dislocation, wound infection, implant fracture, silicone synovitis and nerve compression.

Reoperation rate

We performed analysis of the reoperation rate of patients who underwent surgery. Reoperation may have been instigated by a number of factors including debilitating pain or loss of function.

Trapeziometacarpal joint imaging

We performed analysis of the effect of surgery on trapeziometacarpal joint imaging for studies with more than one year follow-up. The continuous variable of scapho-metacarpal distance at rest was reported in mm.

Minor outcomes

We measured the following minor outcomes:

Range of motion

We performed analysis of the effect of surgery on range of motion for continuous variables. The amount of palmar abduction (web space) was measured in degrees or centimetres (Casanova 1992).

Strength

We performed analysis of the effect of surgery on strength for continuous variables. The continuous variable of lateral pinch strength was measured in kg or kp/cm^2.

Search methods for identification of studies

Electronic searches

We searched the following databases up to 08 August 2013:

- Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2013, Issue 8);
- MEDLINE (1950 to 08 August 2013);
- EMBASE (1947 to 08 August 2013);
- CINAHL (1982 to 08 August 2013);
- ClinicalTrials.gov (to August 2013); and
- World Health Organization (WHO) Clinical Trials Portal (http://apps.who.int/trialsearch) (to August 2013).

We described the search strategy for electronic databases in the Appendices (Appendix 1; Appendix 2; Appendix 3; Appendix 4; Appendix 5; Appendix 6).

In previous updates of this review we included searches in the AMED database. However, we discontinued searches of this database as it is not suitable for a surgical review. Previously, we only identified two articles from the AMED database, which we excluded based on title and abstract.

Searching other resources

We searched reference lists of included studies, textbooks and review articles for relevant studies.

Data collection and analysis

Selection of studies

One review author (TV) screened the articles obtained from the searches by title and abstract and excluded irrelevant studies. Two review authors (AW and TV) independently examined potentially relevant studies using predetermined criteria, which were: the study was prospective, and randomised, quasi-randomised or controlled; the intervention was surgery (either metacarpal osteotomy, trapeziometacarpal arthrodesis, trapeziectomy (complete or partial) with or without LRTI, IA or joint replacement); and pain, physical function, patient global assessment, range of motion or strength was measured as an outcome. We ranked studies as excluded, included or uncertain using a checklist. We resolved any disagreements by discussion between AW and TV. Where agreement was not reached, we consulted a third author (LA) to resolve disagreements. We did not exclude studies on the basis of previous intervention or procedures to the metacarpophalangeal joint. We did not identify any potentially relevant, non-English studies requiring translation.

Data extraction and management

Two review authors (AW and TV) extracted descriptions of the studies including methods, inclusion criteria, participants' characteristics, description of the surgical procedures and outcome measures reported. We extracted the number of participants as well as the mean and standard deviations (SDs) of outcome measures from each of the studies. If a study did not provide the mean and SDs, but instead reported the median and interquartile range (IQR), the median and IQR were used to calculate the mean and 95% confidence interval (CI) using the assumption that mean was between equidistant between the upper and lower values of the IQR. We then made the assuming that the IQR was 0.674 SDs either side of the mean (and the 95% CI was two SDs either side of the mean).

We grouped together studies that compared the same two techniques despite minor variations (e.g. differences in post-operative care) as long as the technique followed the same principles (e.g. IA required the use of tendon to be placed and fixed into the trapezial space).

If we extracted more than one measure for an outcome from the studies used in any one comparison we used the following hierarchy for inclusion in the 'Summary of findings' table (highest to lowest):

- Pain: overall pain, pain at rest, pain on activity, extracted as a heirarchy;
- Physical function: DASH score, Buck-Gramcko score, patient rated wrist evaluation. We gave preference to continuous scores over scores that were reported as categorical data.
- Quality of life: SF-36, other quality of life surveys;
- Participant global assessment: overall patient satisfaction, questions asking if a participant would undergo the procedure again;
- Adverse events: overall rates of adverse events. If two or less different adverse events were reported in the methods or results, they were reported separately and two review authors (AW and TV) made a joint decision on the more pertinent adverse event outcome to be included in the 'Summary of findings' table;
- Treatment failure: reoperation rates with new technique, reoperation rates with repeat of initial technique;
- Trapeziometacarpal joint imaging: qualitative outcomes (e.g. scapho-metacarpal distance), quantitative results (e.g. abutment of the metacarpal on the trapezium).

In addition to primary outcomes, we collected all range of motion and strength outcomes reported. Ranking of this data was not required as we did not intend to conduct any meta-analysis on outcomes that were collected in different methods.

In addition to the above data extraction methods, we made the following decisions on intra-study data extraction:

- If data was analysed based on an intention-to-treat (ITT) sample and another sample (e.g. per-protocol, as treated), we extracted the ITT data. If the outcome was not reported as an ITT but instead as another sample, we still extracted the other sample;
- In some studies data was presented as absolute post-operative outcomes or difference between pre-operative and post-operative outcomes. In all studies we only extracted absolute post-operative outcomes. No attempt to extract difference in pre-operative and post-operative outcomes;
- If participants were followed up at more than once post-operatively, the results from the final follow-up were used.

We anticipated doing subgroup analysis based on period of follow-up (three to 12 months, one to five years, five to 10 years, and greater than 10 years). However we encountered a number of hurdles. Firstly, many studies simply reported the results of the final follow-up leading to wide ranges of follow-up on reported results (e.g. Gangopadhyay 2012 reviewed patients to a final follow-up between five and 18 years). This means we could not group results according to follow-up period. Secondly, we identified too few studies to do perform an effective subgroup analysis. As a result, we did not perform any subgroup analysis based on period of follow-up.

Assessment of risk of bias in included studies

Two review authors (EC and TV) independently assessed the studies for risk of bias using the Cochrane Collaboration's Risk of bias tool (see 'Characteristics of included studies' table). We resolved disagreement by discussion between the review authors.

Measures of treatment effect

For continuous outcomes with common units of measurement, we reported the effect sizes as mean differences (MD) with 95% CIs. For continuous outcomes measured in different scales, we used the standardised mean difference (SMD) with 95% CIs to pool results. The SMD scale we used was that of the outcome with the most participants.
For dichotomous outcomes, we calculated the risk ratio (RR) and 95% CIs.

Unit of analysis issues

Gangopadhyay 2012 measured outcomes between three groups (trapeziectomy alone, trapeziectomy with IA, and trapeziectomy with LRTI). We used this study data by analysing three pairwise comparisons and did not include the study twice in any meta-analysis.

Dealing with missing data

We contacted trial authors to provide any missing statistics and to clarify unclear data. Dr M Tagil (Tagil 2002), Mr J Field (Field 2007) and Dr T Davis (Davis 2004; Gangopadhyay 2012; Salem 2012) kindly provided further trial details. Dr Tagil confirmed that he didn't do a 12 month follow-up and supplied some demographic data and numbers of patients for preoperative measures and pain outcome data at 43 month review. Mr Field provided preoperative and postoperative data for strength for both groups as well as median and SD values for postoperative pain scores. Dr Davis provided information about which participant groups were used in each of his published studies. He notified us that the same patient cohort was used in his Davis 2004 and Gangopadhyay 2012 studies, and a different cohort was used in his Salem 2012 study.
We sought no further information from any trial authors.
Gangopadhyay 2012 reported median and IQR. We converted this to mean and SD values using the following method:

- Mean was calculated by subtracting quartile 1 (lower IQR) from quartile 3 value (upper IQR) dividing by 2 and then adding it to quartile 1;
- IQR was converted to SD by dividing by 1.34896 using the assumption that the upper and lower values of the IQR were the 75th percentiles.

We then used this information as the mean and for calculating the 95% CIs in our meta-analysis.

Assessment of heterogeneity

We aimed to first assess the studies for clinical homogeneity with respect to the duration of the disorder, stage of osteoarthritis, surgical intervention and outcomes. For studies we considered clinically heterogeneous, we planned to analyse the results separately and not combine them in a meta-analysis. For clinically homogeneous studies, we planned to test statistical heterogeneity using the Q test (Chi^2) and I^2 statistic.
We were unable to assess heterogeneity due to the low number of included studies and comparable outcomes between studies.

Assessment of reporting biases

We had planned to construct funnel plots to identify possible publication bias if at least 10 studies were available for the meta-analysis. Notably, an asymmetrical funnel plot would not necessarily be equated with publication bias. However, we were unable to assess for reporting biases using a funnel plot due to the low number of included studies and comparable outcomes between studies.
For studies published after 1st July 2005, we screened the Clinical Trial Register at the WHO International Clinical Trials Registry Platform (http://apps.who.int/trialsearch) for the trial protocol to evaluate whether selective reporting of outcomes is present (outcome reporting bias). We reported the outcome of our search in the 'Risk of bias' tables.

Data synthesis

We considered studies using similar methods of measurement for the outcomes of pain, physical function, patient global assessment, range of motion, strength, trapeziometacarpal joint imaging or adverse events for pooling. We used RevMan 2014 for analyses. We used a random-effects approach for the primary analysis.

'Summary of findings' table

We presented the main review findings in 'Summary of findings' tables, which provides key information concerning the quality of evidence, the magnitude of the effect of the surgeries examined and the sum of the available data on the main outcomes. We included all of our major outcomes (pain, physical function, quality of life, patient global assessment, adverse events, reoperation rate, and trapeziometacarpal joint imaging) in the 'Summary of findings' tables. These outcomes were included in the 'Summary of findings' table even if no studies in that comparison used that outcome. We limited the 'Summary of findings' tables to seven outcomes and reported the remaining outcomes in the Data and analyses section with the current recommendations of The Cochrane Collaboration and the Cochrane Musculoskeletal Group.

Our main comparison was trapeziectomy alone compared to trapeziectomy with LRTI. We selected this as our main comparison as these two techniques are the two most commonly performed procedures and thus were represented in the most studies (four studies). Other comparisons were represented in fewer studies (one to three studies) and were of similar (low) quality evidence or very low quality evidence.

We used GRADEpro 2014 to evaluate the quality of evidence for outcomes reported in the 'Summary of findings' table. The GRADE system assesses the quality of evidence for each outcome. It specifies four levels of quality (high, moderate, low, very low), based on assessment of five factors: study limitations, consistency of effect, imprecision, indirectness and publication bias. The highest level of quality is applied to RCT evidence that demonstrates no limitations in design, no important inconsistency, no important imprecision, direct comparisons, and no important suspected publication bias. Evidence is downgraded when limitations in design of the study are identified, such as unclear 'allocation concealment', unclear or no 'blinding', unclear 'sequence generation', unclear 'incomplete outcome data' and unclear 'other bias'. An unclear risk of bias indicates a 'serious limitation' in the study. RCT evidence is also downgraded if there was concern regarding the precision of the results. Nilsson 2005 was graded as low quality evidence since it is not randomised, but rather a controlled prospective pilot study. In the case of the results of Nilsson 2005 being combined with Nilsson 2010 to report the pooled outcomes, the evidence was deemed as the lowest quality study.

For all outcomes reported in the 'Summary of findings' table we reported the absolute risk, relative risk or SMD using RevMan 2014. We also reported the absolute and relative changes in the comments section of the 'Summary of findings' table. For dichotomous outcomes, we calculated the absolute change by using the 'risk ratio' of that comparison and converting it to a whole number percentage, the relative change was calculated using the formula '(risk ratio) - 1' and converting the whole number answer to a percentage. We then repeated this using the 95% CIs for each outcome. For continuous outcomes using weighted MD, we calculated the absolute change using the formula '(relative difference)/(scale used in the outcome)' and then converted into a whole number percentage. We determined the relative change using the formula '(relative difference)/(baseline mean of the control group)' and then converted to a percentage. For continuous comparisons using the SMD, we calculated the absolute change using the formula '(SMD)x(SD of the control group baseline mean)/(scale use in the outcome)' and then expressed as percentage. We calculated the relative change using the formula '(SMD)/baseline mean of the control group)' and expressed it as a percentage. The chosen 'baseline mean of the control group' was that of the included study with the most participants included in that analysis. We repeated the above methods to calculate the 95% CIs for all outcomes reported in the 'Summary of findings' tables.

If a meta-analysis demonstrated a statistically significant difference between two techniques we calculated the number needed to benefit (NNTB) or number needed to harm (NNTH) and reported this in the comments column of the 'Summary of findings' table. We calculated the NNTB or NNTH using Visual Rx.

Subgroup analysis and investigation of heterogeneity

We planned subgroup analysis, where data were available, to determine if outcomes differed according to the severity of osteoarthritis based on the stages described by Eaton 1987. However, this was not feasible for two reasons. Firstly, no study reported the number of participants with each stage of osteoarthritis; in many cases they reported a mean and range which could include any number of combinations of each stage. Secondly, results were not reported based on stage, making any meaningful analysis impossible.

RESULTS

Description of studies

Results of the search

The number of 'hits' identified by each of the searches were as follows:

- the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2013, issue 8) - 11;
- MEDLINE (1950 to 8/8/2013) - 85;

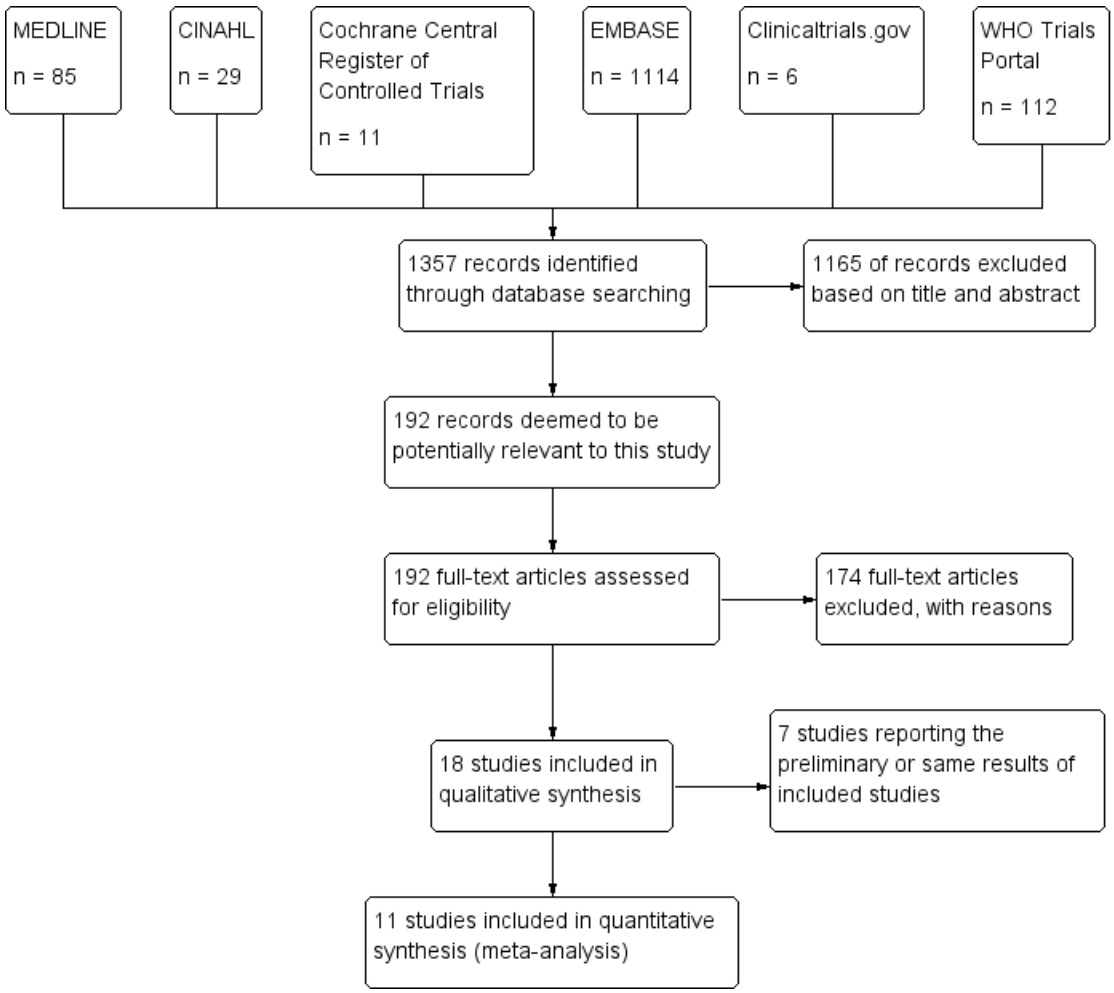
- EMBASE (1947 to 8/8/2013) - 1114;
- CINAHL (1982 to 8/8/2013) - 29;
- ClinicalTrials.gov (to 8/8/2013) - 6; and
- WHO Trials Portal (on 8/8/2013) - 112.

Of the 1357 studies identified by the searches, we excluded 1164 based on the title and abstract. We selected 193 for further assessment. Two authors (AW and TV) independently extracted details such as the type of study, the intervention performed and the outcome measures used in the selected studies. Of these 193 studies we included 18, of which 11 were primary references and seven were supporting. We excluded 174 studies (not including supporting references).

One study (Hansen 2013) is awaiting classification as it compares two new prosthesis with the primary outcome of measuring implant fixation over time. We decided to delay inclusion of this study until the next review update when we will reassess the comparisons chosen for review. As it did not add to any current comparisons, it would not change the outcome of this review.

We have summarised the process of study selection in Figure 1.

Figure 1. Study flow diagram.



Included studies

We identified 11 studies which met the eligibility criteria; ten compared one surgical procedure with another (Belcher 2000;

De Smet 2004; Field 2007; Gerwin 1997; Hart 2006; Kriegs-Au 2004; Nilsson 2005; Nilsson 2010; Salem 2012; Tagil 2002), while one study compared three surgical procedures (Gangopadhyay 2012). Four of these studies (De Smet 2004; Gangopadhyay 2012; Kriegs-Au 2004; Salem 2012) had previously published reports of their data. We did not find any studies that compared surgery to a sham intervention or to a non-surgical intervention.

A total of 670 participants were enrolled, and the number of participants in each study ranged from 15 to 153 (see 'Characteristics of included studies' table). We could not calculate the number of male and female participants enrolled in the studies because Gerwin 1997 did not mention the sex of their participants. Four studies did not state the stage of osteoarthritis (De Smet 2004; Gerwin 1997; Tagil 2002, Salem 2012) of their participants, however there was a predominance of Stage III and IV osteoarthritis in those that did.

There were seven comparisons of one surgical procedure with another across the eleven studies: trapeziectomy with LRTI was compared to trapeziectomy (Belcher 2000; De Smet 2004; Field 2007; Gangopadhyay 2012; Salem 2012); to trapeziectomy with ligament reconstruction (LR) (Gerwin 1997; Kriegs-Au 2004); to trapeziectomy and IA (Gangopadhyay 2012); to Artelon joint resurfacing (Nilsson 2005, Nilsson 2010); or to arthrodesis (Hart 2006); and trapeziectomy with IA was compared to joint replacement (Swanson) surgery by Tagil 2002 and to trapeziectomy by Gangopadhyay 2012.

Pain was an outcome measure in Belcher 2000, De Smet 2004, Field 2007, Gangopadhyay 2012, Kriegs-Au 2004, Nilsson 2005, Nilsson 2010, Salem 2012 and Tagil 2002. Physical function was an outcome measure in Belcher 2000, De Smet 2004, Kriegs-Au 2004, Nilsson 2005, Nilsson 2010, and Salem 2012. Range of motion was an outcome measure in Belcher 2000, Field 2007, Gangopadhyay 2012, Gerwin 1997, Kriegs-Au 2004, Nilsson 2005, Nilsson 2010, Salem 2012 and Tagil 2002. Hart 2006 measured pain, physical function and range of motion but did not report SDs which prevented their inclusion in the analysis. De Smet 2004 measured range of motion but did not report group means and SDs, which also prevented its inclusion in the analysis. All studies had strength as an outcome measure; however, De Smet 2004 reported strength scores as percentage of postoperative/preoperative scores and Hart 2006 did not report SDs, which prevented their inclusion in the analysis. Trapeziometacarpal joint imaging was reported as an outcome measure in Belcher 2000, Field 2007, Gerwin 1997, Nilsson 2010 and Tagil 2002. However, Field 2007 did not report group means and SDs so could not be included in the analysis. All included studies reported adverse events except De Smet 2004 and Gerwin 1997. Nilsson 2005 reported adverse events at two weeks only and these were not included in the 12-month analysis. Hart 2006 reported adverse events but these resolved early on and were not reported at the final analysis at a mean of 6.8 years (two to 10 years).

Three authors provided additional information about their studies:

- Professor Tim Davis (Gangopadhyay 2012; Salem 2012), information about which data was reproduced in later studies;
- Dr Magnus Tagil (Tagil 2002), information about methods; and
- Mr J Field (Field 2007), further information about methods and results.

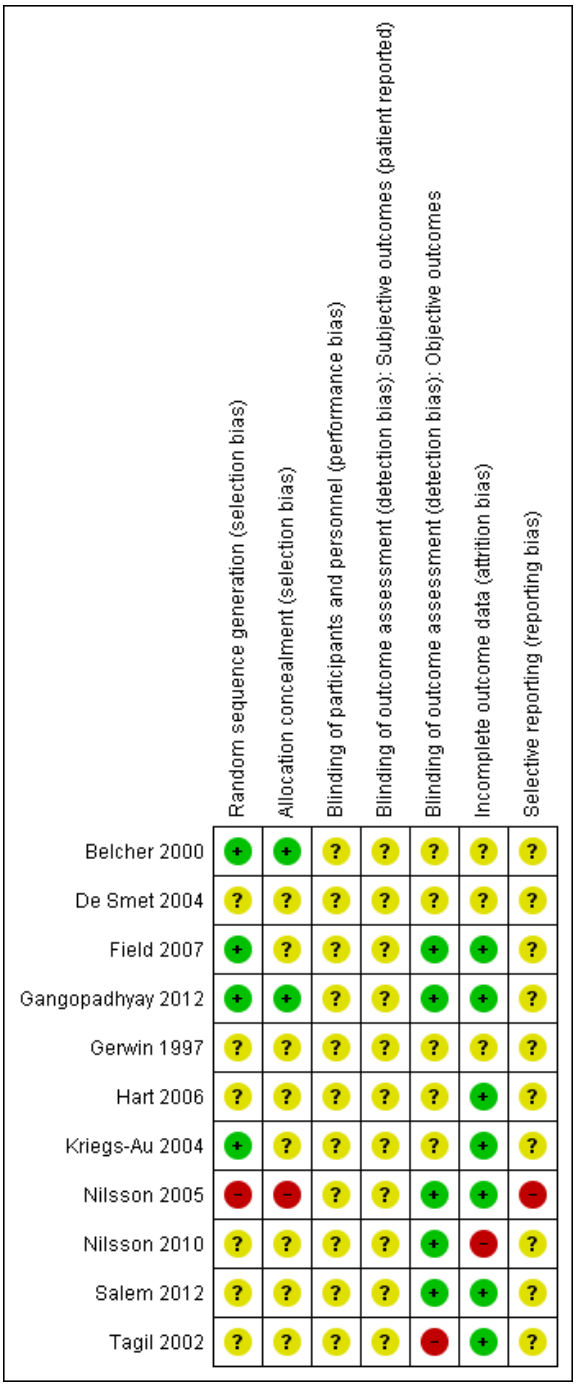
Excluded studies

Of the 185 studies identified, we excluded 174 for the following reasons: reported observational studies (n = 114); reported descriptive studies (n = 20); were reviews (n = 20); had no intervention of interest (n = 12), no comparison of interest (n = 6), no outcome of interest (n = 1) or were terminated at six months due to adverse outcomes in the experimental group and could not be included (n = 1). The study that was terminated early (Belcher 2001) compared trapeziectomy alone to trapeziectomy with porcine xenograft. The trial authors terminated the study at six months due to increased clinical reviews and longer-hospital stays in the xenograft group. Three participants had their xenografts removed and demonstrated foreign body reactions towards the graft. Although this study did not specifically meet our exclusion criteria, we excluded it as it only provided early data on a experimental procedure that was abandoned due to high number of adverse events.

Risk of bias in included studies

We have detailed the risk of bias allocated to studies in the Characteristics of included studies 'Risk of bias' tables and is summarised in Figure 2.

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Allocation

To be free of allocation bias, the study had to report that the randomisation list was generated randomly (though a random task such as flipping a coin or through a random number generator) and was concealed until an appropriate time (ideally after the procedural anaesthesia had been provided).

Two studies reported that allocation sequences were generated by computer randomisation but failed to mention when allocation occurred (Field 2007; Kriegs-Au 2004) thus conferring a low risk of bias for random sequence generation but unclear risk for allocation concealment. Five studies stated that sequences were generated by randomisation but it was unclear if the list was generated in a sufficiently random manner or if the allocated was concealed until an appropriate time (De Smet 2004; Gerwin 1997; Hart 2006; Tagil 2002) and were deemed to be of unclear bias in both categories.

The remaining studies generated sequences by 'spinning a coin' (Belcher 2000; allocation concealed, low risk both categories), by undertaking a controlled prospective pilot study (Nilsson 2005; no randomisation and allocation not concealed, high risk both categories), 'according to the randomisation list' (Nilsson 2010; low risk randomisation, premature allocation, high risk of allocation concealment). Two studies used block randomisation (Gangopadhyay 2012; Salem 2012) where each block of six or nine patients respectively contained three of each surgical procedure. Both studies did not indicate how the list was generated but stated that opaque sequentially numbered envelopes and were low risk of selection bias for random sequence generation. Gangopadhyay 2012 described randomisation during the procedure and was low risk of bias for allocation concealment. However, Salem 2012 did not discuss when allocation took place and performed the alternate procedure on the contralateral hand of patients who had already underwent one procedure for this study. Although this does not achieve randomisation, the same aim is the same (comparable study groups) and thus was deemed unclear risk of bias.

Blinding

Blinding of participants in surgical cases can easily be achieved but blinding of surgeons is impossible. We deemed this study to be of low risk of performance bias if the patient was blinded to the procedure. No included study mentioned blinding of participants and thus we considered all studies were of an unclear risk of performance bias.

Regarding detection bias, objective outcomes (e.g. strength, range of motion or radiographic assessment) were at low risk of bias if the assessors were blinded and subjective outcomes (e.g. pain, quality of life outcomes) were at low risk of bias if the participants were blinded.

Only two studies explicitly stated that they assessors were blinded to the surgery that was performed on each patient they reviewed (Nilsson 2005; Nilsson 2010) and were deemed low risk of bias for objective outcomes. Field 2007 provided assurances in personal communication that assessors were blinded and was also awarded a low risk of bias for objective outcomes. One study stated that "patients returned for blind assessment" (Gerwin 1997) but it was unclear if the observer or participant (or both) were blinded and was deemed to be of unclear risk. One study mentioned independent assessors (Kriegs-Au 2004) but did not state if they assessors were blinded (unclear risk). Salem 2012 states "6 year follow-up assessments were done by a trainee" and although identified that the presence of scars meant blinding was difficult, was still awarded a low risk of bias for identifying the assessor and their blinding status. Gangopadhyay 2012 was award a low risk of bias for similar reasons. Tagil 2002 stated the surgeon who performed the operation conducted the reviews introducing a high risk of bias. It is also unclear from the information provided in the three remaining studies if blinding occurred, which introduces an unclear risk of bias (Belcher 2000; De Smet 2004; Hart 2006).

As stated above, no study stated if participants were blinded about the surgery that was performed until after the final review. As a result, no study was at 'low risk' of detection bias for subjective or patient assessed outcomes or performance bias.

Incomplete outcome data

Several studies appropriately approached incomplete outcome data. A study was at 'low risk' of attrition bias if it was stated which study arm the participants were not reviewed, the reasons that they were not reviewed and if there was no disproportional loss between study arms. Furthermore, if a study lost an appropriate amount of participants to follow-up (10% or less) but did not specify the reasons, it was also awarded a low risk of attrition bias.

Two studies (Field 2007; Hart 2006) followed-up all patients to completion of study. Three studies (Kriegs-Au 2004; Nilsson 2005; Tagil 2002) had patients lost to follow-up and provided information on which group they were allocated and the reason for loss to follow-up. These five studies were at low risk of attrition bias.

One study (Nilsson 2010) had a disproportional loss of participants in their experimental group (nine participants) compared to their control group (three participants). The difference can be partly explained by the 2:1 ratio of allocation to experimental:control and partly by the six patients that were re-operated on in the experimental group. However, the exclusion of the re-operated patients from the final analysis means that the analysed experimental group may have performed better than had they been included. As a result we decided it was at high risk of bias.

Gerwin 1997 did not address incomplete outcome data which introduces an uncertain risk of bias. In Kriegs-Au 2004, 12/43 patients were not included in the final assessment. Although similar numbers dropped out of control (seven) and experimental (five) groups this large number of 'drop-outs' introduces a high risk of bias. All other studies adequately addressed incomplete outcome data. Gangopadhyay 2012 and Salem 2012 had patients drop out of the study and listed reasons, however they had an appropriate loss to follow-up (less than 15%) given the follow-up time (greater than five and at six years, respectively) and we considered them at low risk. Belcher 2000 specified that one patient was lost to follow-up but did not state which operation they received (low risk).

Selective reporting

We identified the protocols of only two studies (Field 2007; Gangopadhyay 2012) by searching the WHO International Clinical Trials Registry Platform. However, inadequate or no information was provided on outcomes that were to be assessed and both protocols were published after the recruitment of the first patient. As a result, we considered both studies were at unclear risk of bias. Nilsson 2005 and Nilsson 2010 were both sponsored by the manufacturer of the intervention (Artimplant AB, Goteborg, Sweden). Nilsson 2010 stated that 'the sponsor monitored the study, collected and analysed the data and gave support for the manuscript' but no evidence of selective reporting was identified and without the protocol, the study was awarded an unclear risk of bias. Nilsson 2005 reported on Sollerman hand score in the methods but did not reported this outcome in results awarding the study a high risk of bias.

We did not identify any other protocols for any included studies. Thus we deemed all remaining studies to be at low risk of reporting bias.

Effects of interventions

See: **Summary of findings for the main comparison** Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T); **Summary of findings 2** Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR); **Summary of findings 3** Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and interpositional arthroplasty (T and IA); **Summary of findings 4** Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon joint resurfacing; **Summary of findings 5** Trapeziectomy with interpositional arthroplasty (T and IA) versus trapeziometacarpal joint replacement (Swanson); **Summary of findings 6** Trapeziectomy with interpositional arthroplasty (T and IA) versus trapeziectomy (T)

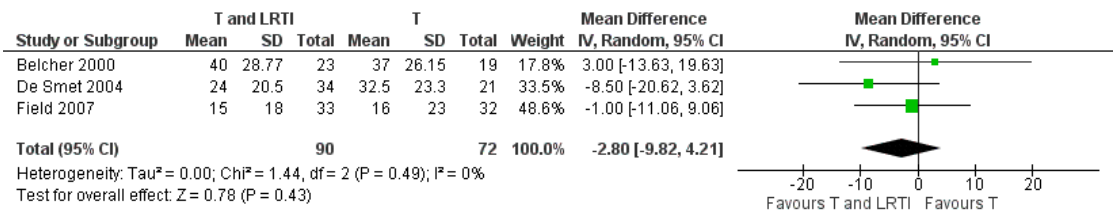
Comparison 1: Trapeziectomy with LRTI versus trapeziectomy

Five studies compared trapeziectomy with LRTI to trapeziectomy (T), namely Belcher 2000 (using abductor pollicis longus (APL)), Gangopadhyay 2012 (using flexor carpi radialis (FCR)), De Smet 2004 (using FCR), Field 2007 (using half of FCR) and Salem 2012 (using FCR). No study reported quality of life outcomes, patient global assessment or treatment failure in this comparison. We have summarised this comparison and the number of participants for each outcome in Summary of findings for the main comparison.

Pain

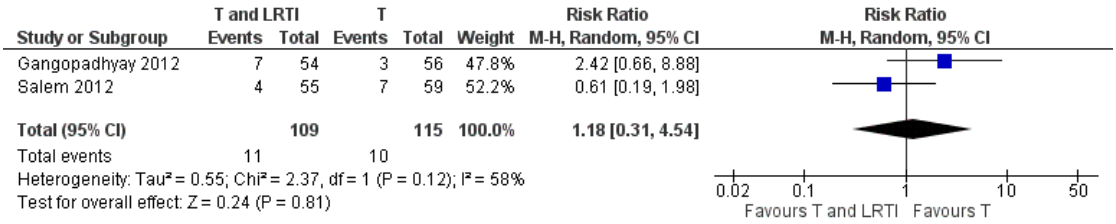
Three studies compared pain on a continuous 100 mm VAS (Belcher 2000; De Smet 2004; Field 2007). There was no difference in pain relief between trapeziectomy with LRTI and trapeziectomy (MD -2.8 mm, 95% CI -9.82 to 4.21, random-effects, P = 0.43; Analysis 1.1; Figure 3).

Figure 3. Forest plot of comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus Trapeziectomy (T), outcome: 1.1 Pain - 100 mm VAS (post-intervention).



Two studies measured pain on a dichotomous scale, recording the number of participants with resting pain (Gangopadhyay 2012; Salem 2012). There was no difference in the number of participants with resting pain between trapeziectomy with LRTI versus trapeziectomy (RR 0.9 subject, 95% CI 0.12 to 6.79, random-effects, P = 0.92) (Analysis 1.2; Figure 4).

Figure 4. Forest plot of comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), outcome: 1.2 Pain - number of participants with resting pain.



Physical function

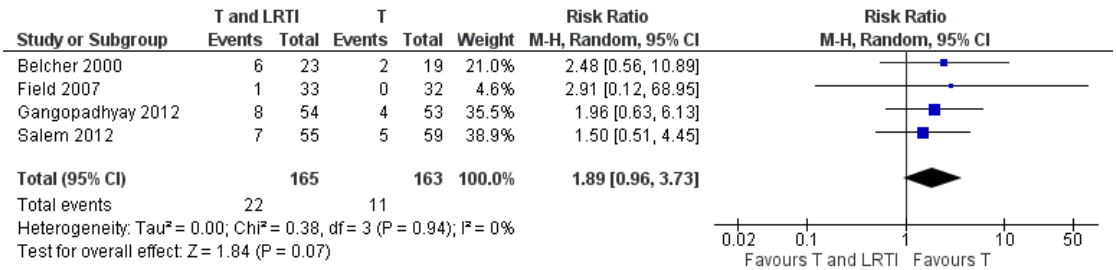
One study measured physical function on a continuous 100 mm VAS scale (Belcher 2000). Two studies (De Smet 2004; Salem 2012) measured function on the DASH scale. In both scales, 0 = normal function and 100 = maximal disability.

Combining the results there was no difference in function between trapeziectomy with LRTI and the trapeziectomy alone group (SMD 0.01, 95% CI -0.30 to 0.32, random-effects; Analysis 1.3). The demonstrated effect size was equivalent to a worsening of physical function by 0.03 points (95% CI -0.83 to 0.88) on a scale of 0 to 100 for trapeziectomy with LRTI compared to trapeziectomy alone.

Adverse events

Four studies reported adverse events (Belcher 2000; Field 2007; Gangopadhyay 2012; Salem 2012). There was no significant difference in adverse events with the trapeziectomy with LRTI group compared to the trapeziectomy group (RR 1.89, 95% CI 0.96 to 3.73, random-effects, P = 0.07; Table 1; Analysis 1.4; Figure 5).

Figure 5. Forest plot of comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), outcome: 1.11 Adverse events - number of participants with adverse events (post-intervention).



Trapeziometacarpal joint imaging

One study measured scapho-metacarpal distance in mm (Belcher 2000). There was no difference in the scapho-metacarpal distance between trapeziectomy with LRTI when compared with trapeziectomy (MD -0.10 mm, 95% CI -0.81 to 0.61, random-effects; Analysis 1.5).

Range of motion

One study measured range of palmar abduction motion in cm (Belcher 2000). There was significantly more range in the trapeziectomy with LRTI group compared with the trapeziectomy group (MD 0.3 cm, 95% CI 0.03 to 0.57, random-effects; Analysis 1.6).

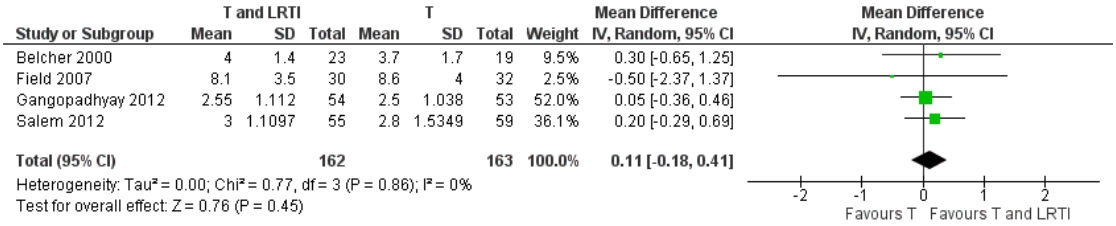
One study measured range of palmar abduction motion in degrees (Field 2007). There was significantly more range in the trapeziectomy with LRTI group compared with the trapeziectomy group (MD 8 degrees, 95% CI 1.47 to 14.53, random-effects; Analysis 1.7).

Strength

Two studies measured tip pinch strength in kg (Gangopadhyay 2012, Salem 2012). There was no difference in tip pinch strength in the trapeziectomy with LRTI group compared to the trapeziectomy group (MD -0.13 kg, 90% CI -0.26 to 0.52, random-effects, P = 0.52; Analysis 1.8).

Three studies measured lateral pinch strength in kg (Belcher 2000; Field 2007; Gangopadhyay 2012). There was no difference in lateral pinch strength between trapeziectomy with LRTI and trapeziectomy (MD 0.11 kg, 95% CI -0.18 to 0.41, random-effects, P = 0.45; Analysis 1.9; Figure 6).

Figure 6. Forest plot of comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), outcome: 1.9 Strength - lateral (key) pinch strength (kg).



Two studies measured grip strength in kg (Gangopadhyay 2012, Salem 2012). There was no difference in grip strength between trapeziectomy with LRTI and trapeziectomy (MD 0.59 kg, 95% CI -3.12 to 4.29, random-effects, P = 0.76; Analysis 1.10).

Comparison 2: Trapeziectomy with LRTI versus trapeziectomy with ligament reconstruction

Two studies compared trapeziectomy with LRTI to trapeziectomy with ligament reconstruction (Gerwin 1997; Kriegs-Au 2004). No study reported on treatment failure in this comparison.

We summarised this comparison and the number of participants for each outcome in Summary of findings 2.

Pain

One study measured pain on a dichotomous scale, recording the number of participants with frequent or resting pain (Kriegs-Au 2004). There was no difference in the number of participants with frequent or resting pain between trapeziectomy with LRTI and trapeziectomy with ligament reconstruction (RR 2.8 subject, 95% CI 0.33 to 24.16, random-effects; Analysis 2.1).

Physical function

One study reported patient global assessment (Kriegs-Au 2004) on a dichotomous scale. The Buck-Gramcko Scale reported the number of participants with good to excellent scores, i.e. scores between 40 and 56. There was no difference between the number of participants with good to excellent scores in the trapeziectomy with LRTI group when compared to trapeziectomy with ligament reconstruction (RR 0.82, 95% CI 0.63 to 1.06, random-effects; Analysis 2.3).

The same study reported that there was no difference between the number of participants with moderate or severe difficulty with daily function in the trapeziectomy with LRTI group when com-

pared to trapeziectomy with ligament reconstruction (RR 2.8 subject, 95% CI 0.33 to 24.16, random-effects; Analysis 2.2).
Quality of life, patient global assessment and treatment failure were not reported for this comparison.

Adverse events

One study reported adverse events (Kriegs-Au 2004). There was no difference in adverse events between trapeziectomy with LRTI when compared to trapeziectomy with ligament reconstruction (RR 1.41 subject, 95% CI 0.27 to 7.28, random-effects; Table 2; Analysis 2.4).

Trapeziometacarpal joint imaging

One study measured scapho-metacarpal distance at rest in mm (Gerwin 1997). There was no difference in the scapho-metacarpal distance at rest between the trapeziectomy with LRTI group when compared to the trapeziectomy with ligament reconstruction group (MD -0.70 mm, 95% CI -1.90 to 0.50, random-effects; Analysis 2.5).

Range of motion

Two studies measured range of palmar abduction motion in degrees (Gerwin 1997; Kriegs-Au 2004). There was no difference in the range of palmar abduction between the trapeziectomy with LRTI group when compared with trapeziectomy and ligament reconstruction (MD -1.03 degrees, 95% CI -7.81 to 5.75, random-effects, P = 0.77; Analysis 2.6).

Strength

One study measured lateral pinch strength in kg (Gerwin 1997). There was no difference in lateral pinch strength between trapeziectomy with LRTI when compared to trapeziectomy and ligament reconstruction (MD -0.60, 95% CI -1.93 to 0.73, random-effects; Analysis 2.7).

Comparison 3: Trapeziectomy with LRTI versus trapeziectomy with IA

Only one study, Gangopadhyay 2012, compared trapeziectomy with LRTI to trapeziectomy with IA. No study reported on physical function, quality of life outcomes, quality of life outcomes, patient global assessment, treatment failure trapeziometacarpal joint imaging or range of motion in this comparison.
This comparison and the number of participants for each outcome is summarised in Summary of findings 3.

Pain

Gangopadhyay 2012 measured pain on a dichotomous scale, recording the number of participants with frequent or resting pain. There was no difference in the number of participants with frequent or resting pain between trapeziectomy with LRTI and trapeziectomy with IA (RR 1.49, 95% CI 0.47 to 4.77, random-effects; Analysis 3.1).

Adverse events

There was no difference in the adverse events between trapeziectomy with LRTI when compared to trapeziectomy with IA (RR 1.36, 95% CI 0.96 to 3.73, random-effects; Table 3; Analysis 3.2).

Strength

Gangopadhyay 2012 measured lateral pinch strength in kg. There was no difference in tip pinch between trapeziectomy with LRTI when compared to trapeziectomy with IA (MD 0.05 kg, 95% CI -0.51 to 0.61, random-effects; Analysis 3.3).
Furthermore, there was no difference in lateral (key) pinch strength between trapeziectomy with LRTI when compared to trapeziectomy with IA (MD 0.20 kg, 95% CI -0.51 to 0.61, random-effects; Analysis 3.3).
One study measured grip-strength in kg (Gangopadhyay 2012). There was no difference in grip strength between trapeziectomy with LRTI when compared to trapeziectomy with IA (MD 1.00 kg, 95% CI -4.25 to 6.25, random-effects; Analysis 3.4).

Comparison 4: Trapeziectomy with IA versus Artelon implant

Two industry-funded studies compared trapeziectomy with IA versus Artelon implant (Nilsson 2005; Nilsson 2010). Nilsson 2005 used APL tendon for interposition while Nilsson 2010 used a mixture of APL (22 cases), extensor carpi radialis longus (ECRL; six cases) and FCR (nine cases). No study reported on quality of life outcomes or trapeziometacarpal joint imaging in this comparison. We summarised this comparison and the number of participants for each outcome in Summary of findings 4.

Pain

Two studies measured pain on a continuous 100 mm VAS scale examining the effect of trapeziectomy with IA compared to Artelon joint resurfacing (Nilsson 2005; Nilsson 2010). Nilsson 2010 reported pain during two pinch actions and these are reported separately.
There was no difference between trapeziectomy with IA when compared to Artelon joint resurfacing during key pinch (MD -3.4 mm, 95% CI -23.77 to 17.29, random-effects; Analysis 4.1).
During tripod pinch, people who had trapeziectomy with IA had

significantly less pain when compared to people who had Artelon joint resurfacing (MD -14.00 mm, 95% CI -23.06 to -4.94, random-effects; Analysis 4.2).

Physical function

Nilsson 2005 measured physical function using the Sollerman hand function test. Unfortunately the results were not provided in the study and we could not contact the author to supply the missing data.
Nilsson 2010 measured DASH score but only reported the difference in scores pre- to post-operatively.

Patient global assessment

Only one study measured patient global assessment using a Likert scale (Nilsson 2005). One study measured patient satisfaction on a scale of 1 (not at all satisfied) to 5 (very satisfied/very good) but only reported the outcomes as 'scores above 3' for both groups. Unfortunately the results were not provided in the study and the author could not be contacted to supply the missing data.

Adverse events

One study compared adverse events outcomes as mild to moderate swelling and reoperation due to pain (Nilsson 2010). There was an increase in mild to moderate swelling in the Artelon resurfacing group compared to the trapeziectomy with IA group (MD 0.09, 95% CI 0.01 to 0.61, random-effects; Table 4; Analysis 4.3).

Treatment failure

One study compared treatment failure (reoperation due to pain, Nilsson 2010). There was no difference between the trapeziectomy with IA group and Artelon joint resurfacing group for reoperation due to pain (MD 0.13, 95% CI 0.01 to 2.24, random-effects; Table 4; Analysis 4.4).

Range of motion

Two studies measured range of palmar abduction motion in degrees (Nilsson 2005; Nilsson 2010). There was no difference in the range of palmar abduction between trapeziectomy with IA and Artelon joint resurfacing (MD -4.13, 95% CI -11.16 to 2.91, random-effects, P = 0.25; Analysis 4.5).

Strength

Two studies compared lateral pinch strength in kg (Nilsson 2005; Nilsson 2010). There was no difference in lateral pinch strength following trapeziectomy with IA compared with Artelon joint resurfacing (MD -1.09 kg, 95% CI -2.40 to 0.22, random-effects, P = 0.10; Analysis 4.6).

One study compared tripod pinch strength in kg (Nilsson 2010). There was no significant difference between trapeziectomy with IA and Artelon joint resurfacing (MD -0.70 kg, 95% CI -1.81 to 0.42, random-effects; Analysis 4.7).
One study compared grip strength in kg (Nilsson 2010). There was no significant difference between trapeziectomy with IA and Artelon joint resurfacing (MD -2.00 kg, 95% CI -6.20 to 2.40, random-effects; Analysis 4.8).

Comparison 5: Trapeziectomy with LRTI versus arthrodesis

Hart 2006 compared trapeziectomy with LRTI versus arthrodesis. This study measured outcomes at six months and at a mean of 6.8 years (two to 10 years). We have reported outcomes at 6.8 years in our review. This study included a total of 40 cases (37 patients). No study reported on quality of life outcomes, patient global assessment, adverse events, treatment failure, strength or trapeziometacarpal joint imaging in this comparison.

Pain

The study measured pain using the Buck-Gramcko score. It provided the mean pain score for each of the two groups (T and LRTI = 5.2; arthrodesis = 5.4 at final follow-up at a mean of 6.8 years (two to 10 years)). The statistical significance of these scores is unclear as trial authors did not provide SD values for statistical analysis.

Physical function

The study measured patient global assessment using the Buck-Gramcko score. It provided the mean total score for each of the two groups (T and LRTI = 51.3; arthrodesis = 51.3 at final follow-up at a mean of 6.8 years (two to 10 years)). There would appear to be no difference, however statistical significance is unclear as SDs were not provided for statistical analysis.
Quality of life, patient global assessment, adverse events, trapeziometacarpal joint imaging, strength and treatment failure were not reported for this comparison.

Range of motion

The study measured range of motion using the Buck-Gramcko score. It provided the mean score for each of the two groups (T and LRTI = 5.6; arthrodesis = 5.2 at final follow-up at a mean of 6.8 years (two to 10 years)). The statistical significance is unclear as SDs were not provided for statistical analysis.

Comparison 6: Trapeziectomy with IA versus trapeziometacarpal joint replacement (Swanson)

Tagil 2002 compared trapeziectomy with IA versus trapeziometacarpal joint replacement (Swanson). However the study did not report physical function, quality of life outcomes, patient global assessment or treatment failure for this comparison.

We have summarised this comparison and the number of participants for each outcome in Summary of findings 5.

Pain

The study measured pain on a continuous 100 mm VAS scale examining the effect of trapeziectomy with IA and trapeziometacarpal joint replacement (Tagil 2002). There was no difference in pain relief between trapeziectomy with IA and trapeziometacarpal joint replacement (MD 5.0 mm, 95% CI -7.41 to 17.41, random-effects; Analysis 5.1).

Adverse events

There was no difference in the adverse events between trapeziectomy with IA compared with trapeziometacarpal joint replacement (RR 0.20, 95% CI 0.01 to 3.80, random-effects; Table 5; Analysis 5.2).

Trapeziometacarpal joint imaging

Tagil 2002 measured scapho-metacarpal distance in mm. The scapho-metacarpal distance was significantly less in the trapeziectomy with IA group when compared with trapeziometacarpal joint replacement (MD -3.5 mm, 95% CI -4.96 to -2.04, random-effects; Analysis 5.3).

Range of motion

The study measured range of palmar abduction motion in degrees (Tagil 2002). There was no difference in the range of palmar abduction between trapeziectomy with IA and trapeziometacarpal joint replacement (MD 2.0 degrees, 95% CI -3.01 to 7.01, random-effects; Analysis 5.4).

Strength

There was one study which measured lateral pinch strength in kp/cm^2 (Tagil 2002). There was no difference in lateral pinch strength between trapeziectomy with IA when compared with trapeziometacarpal joint replacement (MD 0.01 kp/cm^2, 95% CI -0.09 to 0.11, random-effects; Analysis 5.5).

Comparison 7: Trapeziectomy with interpositional arthroplasty versus trapeziectomy

Gangopadhyay 2012 compared trapeziectomy with IA versus trapeziectomy. No study reported physical function, quality of life outcomes, patient global assessment, range of motion, trapeziometacarpal joint imaging and treatment failure for this outcome.

We summarised this comparison and the number of participants for each outcome in Summary of findings 6.

Pain

Gangopadhyay 2012 measured pain on a dichotomous scale, recording the number of participants with resting pain. There was no difference in the number of participants with frequent or resting pain between trapeziectomy with IA and trapeziectomy (MD 0.20, 95% CI 0.01 to 3.80, random-effects; Analysis 6.1).

Strength

Gangopadhyay 2012 measured lateral pinch strength, tip pinch strength and grip strength in kg. There was no difference in lateral pinch strength between trapeziectomy with IA when compared to trapeziectomy (MD -0.20 kg, 95% CI -1.15 to 0.75, random-effects; Analysis 6.3).

There was also no difference in tip pinch strength between trapeziectomy with IA when compared to trapeziectomy (MD 0.00 kg, 95% CI -0.55 to 0.55, random-effects; Analysis 6.4).

There was no difference in grip strength between trapeziectomy with IA when compared to trapeziectomy (MD -2.50 kg, 95% CI -6.94 to 1.94, random-effects; Analysis 6.5).

Adverse events

Gangopadhyay 2012 reported adverse events. There was no difference in the adverse events with trapeziectomy and IA when compared with trapeziectomy (MD 1.44, 95% CI 0.41 to 5.05, random-effects; Table 6; Analysis 6.2).

We were unable to report whether there was any improvement or deterioration in outcomes between the 12 month review and five year follow-up following surgery for trapeziometacarpal osteoarthritis because of lack of outcome data.

ADDITIONAL SUMMARY OF FINDINGS *[Explanation]*

Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR)

Patient or population: Patients with thumb (trapeziometacarpal joint) osteoarthritis
Settings: Hospital
Intervention: Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI)
Comparison: Trapeziectomy and ligament reconstruction (T and LR)

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Trapeziectomy and ligament reconstruction (T and LR)	Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI)				
Pain - not measured	See comment	See comment	Not estimable	-	See comment	Participant-reported pain relief of 50% or greater or VAS pain scores not reported in any study
Physical function Buck-Gramcko score: Number with good-excellent total score Follow-up: 15 to 120 months	**Moderate**		**RR 0.82** (0.63 to 1.06)	31 (1 study)	⊕⊕◯◯ **low**[1,2]	Absolute change of -19% (-40% to 2%); Relative decrease 18% (-35% to 27%)
	100 per 100	**82 per 100** (63 to 100)				
Quality of life - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Global assessment - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.

Adverse events Complications reported Follow-up: 15 to 120 months	**Moderate** **13 per 100**	**19 per 100** (4 to 97)	**RR 1.41** (0.27 to 7.28)	31 (1 study)	⊕⊕◯◯ **low**[1,2]	Absolute change 5% (-20% to 31%); Relative change 41% (-73% to 628%)
Treatment failure - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Trapeziometacarpal joint imaging Scapho-metacarpal distance Follow-up: mean 23 months	The mean trapeziometacarpal joint imaging in the control groups was **5.2 mm**	The mean trapeziometacarpal joint imaging in the intervention groups was **0.7 lower** (1.9 lower to 0.5 higher)		20 (1 study)	⊕⊕◯◯ **low**[2,3]	Absolute and relative change cannot be calculated[4].

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio.

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Kriegs-Au 2004: Unclear selection bias; unclear performance bias; unclear detection bias, unclear reporting bias.
[2] Less than 300 total participants (imprecision).
[3] Gerwin 1997: Unclear selection bias; unclear performance bias; unclear detection bias; unclear attrition bias; unclear reporting bias.
[4] Absolute change cannot be calculated as there is no scale for trapeziometacarpal joint space imaging. Relative change cannot be calculated as there is no baseline mean in any control groups as this space is created during the surgery.

Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and interpositional arthroplasty (T and IA)

Patient or population: Patients with thumb (trapeziometacarpal joint) osteoarthritis
Settings: Hospital
Intervention: Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI)
Comparison: Trapeziectomy and interpositional arthroplasty (T and IA)

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Trapeziectomy and interpositional arthroplasty (T and IA)	Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI)				
Pain - not measured	See comment	See comment	Not estimable	-	See comment	Participant-reported pain relief of 50% or greater or VAS pain scores not reported in any study
Physical function - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Quality of life - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Global assessment - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Adverse events complications reported Follow-up: 5 to 18 years	**Moderate**		**RR 1.36** (0.48 to 3.88)	100 (1 study)	⊕⊕⊕◯ **moderate**[1,2]	Absolute change of 4% (-9% to 17%); Relative change 36% (-52% to 288%)

	24 per 100	**32 per 100** (11 to 92)				
Treatment failure - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Trapeziometacarpal joint imaging - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio.

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Gangopadhyay 2012: Unclear performance bias; unclear reporting bias.
[2] Less than 300 total participants (imprecision).

Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon joint resurfacing

Patient or population: Patients with thumb (trapeziometacarpal joint) osteoarthritis
Settings: Hospital
Intervention: Trapeziectomy with interpositional arthroplasty (IA)
Comparison: Artelon joint resurfacing

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Artelon joint resurfacing	Trapeziectomy with interpositional arthroplasty (IA)				
Pain 100mm VAS. Scale from: 1 to 100. Follow-up: 3 years	The mean pain in the control groups was **21.2 mm**	The mean pain in the intervention groups was **3.2 lower** (23.8 lower to 17.3 higher)		77 (2 studies[1])	⊕◯◯◯ **very low**[2,3]	Absolute change -3% (-24% to 17%); Relative change -7% (-53% to 38%)
Physical function - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Quality of life - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Global assessment - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Adverse events Mild to moderate swelling Follow-up: 1 year	**33 per 100**	**3 per 100** (0 to 20)	**RR 0.09** (0.01 to 0.61)	98 (1 study)	⊕◯◯◯ **very low**[3,4]	Absolute change -30% (-18% to -43%); Relative change -81% (-99% to -49%); Number needed to benefit 4 (4 to 7)

Treatment failure Reoperation due to pain Follow-up: 1 year	**10 per 100**	**1 per 100** (0 to 22)	**RR 0.14** (0.01 to 2.36)	98 (1 study)	⊕◯◯◯ **very low**[3,4]	Absolute change -10% (-1% to -18%); Relative change -86% (-99% to -136%)
Trapeziometacarpal joint imaging - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio.

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Nilsson 2005: Controlled, prospective pilot study.
[2] Nilsson 2005: High risk selection bias; unclear performance bias; unclear detection bias; high risk reporting bias.
[3] Less than 300 total participants (imprecision).
[4] Nilsson 2010: Unclear selection bias; unclear performance bias; unclear detection bias; high risk attrition bias; unclear reporting bias.

Trapeziectomy with interpositional arthroplasty (T and IA) versus trapeziometacarpal joint replacement (Swanson)

Patient or population: Patients with thumb (trapeziometacarpal joint) osteoarthritis
Settings: Hospital
Intervention: Trapeziectomy with interpositional arthroplasty (T and IA)
Comparison: Trapeziometacarpal joint replacement (Swanson)

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Trapeziometacarpal joint replacement (Swanson)	Trapeziectomy with interpositional arthroplasty (T and IA)				
Pain 100mm VAS. Scale from: 0 to 100. Follow-up: 22 to 66 months	The mean pain in the control groups was **9.0 mm**	The mean pain in the intervention groups was **5.0 higher** (7.4 lower to 17.4 higher)		26 (1 study)	⊕⊕◯◯ **low**[1,2]	Absolute change 5% (-7.4% to 17%); Relative change 8% (-12% to 27%)
Physical function - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Quality of life - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Global assessment - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Adverse events Complications reported Follow-up: 22 to 66 months	**Moderate**		**RR 0.2** (0.01 to 3.8)	26 (1 study)	⊕⊕◯◯ **low**[1,2]	Absolute change -15% (-82% to 7%); Relative change -80% (-99% to 280%)

	15 per 100	**3 per 100** (0 to 59)				
Treatment failure - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Trapeziometacarpal joint imaging - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio.

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Tagil 2002: Unclear selection bias; unclear performance bias; high risk detection bias; unclear reporting bias.
[2] Less than 300 total participants (imprecision).

Trapeziectomy with interpositional arthroplasty (T and IA) versus trapeziectomy (T)

Patient or population: Patients with thumb (trapeziometacarpal joint) osteoarthritis
Settings: Hospital
Intervention: Trapeziectomy with interpositional arthroplasty (T and IA)
Comparison: Trapeziectomy (T)

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Trapeziectomy (T)	Trapeziectomy with interpositional arthroplasty (T and IA)				
Pain - not measured	See comment	See comment	Not estimable	-	See comment	Participant-reported pain relief of 50% or greater or VAS pain scores not reported in any study
Physical function - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Quality of life - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Global assessment - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Adverse events Complications reported Follow-up: 5 to 18 years	**Moderate**		**RR 1.44** (0.41 to 5.05)	99 (1 study)	⊕⊕⊕◯ **moderate**[1,2]	Absolute change 3% (-8% to 15%); Relative change 44% (-59% to 405%)

	14 per 100	**21 per 100** (6 to 73)				
Treatment failure - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.
Trapeziometacarpal joint imaging - not measured	See comment	See comment	Not estimable	-	See comment	Not reported in any study.

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio.

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Gangopadhyay 2012: Unclear performance bias; unclear reporting bias.
[2] Less than 300 total participants (imprecision).

DISCUSSION

Summary of main results

The trapeziometacarpal joint is the site most commonly requiring surgical reconstruction for osteoarthritis in the upper extremity (Pellegrini 1993). Many surgical procedures have been described for this condition, with preferences largely based on personal experience rather than a 'methodologically sound assessment of primary studies' (Martou 2004). The purpose of this systematic review of randomised controlled clinical trials was to determine whether any one procedure is superior to another for a given stage of trapeziometacarpal osteoarthritis.

Most studies reported the outcomes of interest which were pain, physical function, patient global assessment, range of motion, strength, trapeziometacarpal joint imaging and adverse events. However, it was still difficult to compare studies because there were crucial differences in the reporting and taking of outcome measurements. Firstly, some outcomes were measured continuously and dichotomously. For example, pain was measured by different researchers on a continuous scale (VAS; Belcher 2000) and a dichotomous scale (Gangopadhyay 2012). This prevented pooling of data and required separate analyses. Secondly, some outcomes were measured using the same continuous scale but with different measurement tools and reported in different units. For example, Gangopadhyay 2012 measured lateral pinch strength with the Jamar dynamometer and reported this in kg in while Tagil 2002 measured with a Martins Vigorimeter and reported in kp/cm^2. Thirdly a variety of measures were sometimes reported for the same outcome. For example, various measurements of range of motion were taken, including palmar and radial abduction, opposition and the amount of flexion deficit. In these cases, we chose to analyse the most commonly-reported and clinically-relevant outcomes (palmar abduction and radial abduction) to facilitate comparison between studies. Lastly, some studies reported absolute or percentage change of outcome measures, or failed to provide SDs. It was only possible to include their results in the analysis when the trial authors sent further information.

All included studies measured pain except Gerwin 1997. Hart 2006 measured pain but did not provide sufficient data for statistical analysis. This left nine comparisons (six continuous and three dichotomous) of pooled studies for the seven procedures. There was significant difference in pain between trapeziectomy with IA compared to Artelon joint resurfacing. However, there was no significant difference in pain between any other reported procedures, i.e. no other procedure appears to be superior to any other in the relief of pain. However, if we consider the smallest clinical effect worth detecting to be a difference of 2 cm on the VAS or a 20% reduction in the number of participants with resting pain, then the 95% CIs for the effect on pain exclude a worthwhile effect. Therefore, there is not enough power to be conclusive that no difference in pain exists between the five procedures.

Physical function was not measured consistently across all studies. Three studies measured physical function on a continuous scale, one used the 100 mm VAS (Belcher 2000), while two studies used the DASH questionnaire (De Smet 2004; Salem 2012). One study measured physical function on a dichotomous scale, reporting the number of participants with 'moderate difficulty with daily function' as part of the Buck-Gramcko score (Kriegs-Au 2004). This provided two continuous comparisons and one dichotomous comparison for two procedures. Hart 2006 measured physical function using the Buck-Gramco score but did not provide sufficient data for statistical analysis.There was no significant difference in physical function between procedures in any comparison, with no procedure appearing superior to any other in the improvement of physical function. However, if we consider the smallest clinical effect worth detecting to be a 2 cm decrease in physical function (0 = full function) or a 20% reduction in the number of participants with difficulty with daily function, then the 95% CIs for the effect on physical function exclude a worthwhile effect. Therefore, there is not enough power to be conclusive that no difference in physical function exists between two of the procedures.

Two studies measured global patient assessment. Hart 2006 did not provide SDs necessary for statistical analysis. Kriegs-Au 2004 provided sufficient data to produce a dichotomous comparison for two procedures. There was no significant difference in patient global assessment between procedures, i.e., no procedure appears to be superior to any other in the improvement in patient global assessment. However, if we consider the smallest clinical effect worth detecting to be a difference of ten points on the Buck-Gramcko scale, then the 95% CIs for the effect on pain exclude a worthwhile effect. Therefore, there is not enough power to be conclusive that no difference in patient global assessment exists between the two procedures.

Nine studies measured range of motion. However, only seven included the measurement of palmar abduction in degrees or centimetres for individual groups in their study (Belcher 2000; Field 2007; Gerwin 1997; Kriegs-Au 2004; Nilsson 2005; Nilsson 2010; Tagil 2002). This provided seven continuous outcomes for six procedures. A statistically significant increased range of palmar abduction was found after trapeziectomy with LRTI over trapeziectomy in both degrees and centimetres. However, this difference was not clinically significant amounting to only a few degrees or millimetres. There was no significant difference in range of palmar abduction between the other five procedures.

Nine studies measured strength with eight studies providing actual values (Belcher 2000; Field 2007; Gangopadhyay 2012; Gerwin 1997; Nilsson 2005; Nilsson 2010; Salem 2012; Tagil 2002). This provided continuous outcomes for six procedures. There was no significant difference in lateral pinch strength between any procedures.

Trapeziometacarpal joint imaging provided measures of scaphometacarpal distance (mm) and three studies reported this (Belcher 2000; Gerwin 1997; Tagil 2002). It has historically been consid-

ered that greater distance is desirable, to maintain length of the thumb and thereby preserve strength. The only significant difference in the scapho-metacarpal distance was in Tagil 2002, which compared trapeziometacarpal joint replacement (Swanson) with trapeziectomy and IA (APL). Joint replacement demonstrated better preservation of scapho-metacarpal distance but was not associated with any increase in thumb strength. These findings confirm the conclusions of Davis 2004 and Lins 1996 who also did not find any association between scapho-metacarpal distance and thumb strength. Only De Smet 2004 reported a correlation between scapho-metacarpal distance and thumb strength. However, this correlation (r = 0.36) is not strong enough (Domholdt 2000) to support a relationship between thumb length and pinch strength.
Of the 11 studies, seven provided a detailed description of adverse events at follow-up. Unfortunately, four studies did not report any adverse events at final follow-up (De Smet 2004; Gerwin 1997; Hart 2006; Nilsson 2005). Furthermore, there was no significant continuity between adverse event reporting between most of the studies. For instance, the adverse events fell into the following categories: tendon rupture (FCR)/adhesion; scar tenderness; pain and erythema; sensory changes (includes radial nerve dysfunction); cut palmar branch median nerve; neuroma; instability; CRPS (Type 1); superficial wound infections; mild to moderate pain; and re-operation due to pain.
The incomplete reporting of adverse events makes the meta-analyses of several techniques difficult, particularly those that compared trapeziectomy with trapeziectomy with LRTI. For instance, Belcher 2000 reported five adverse events categories (recurrent pain, instability, neuroma, sensory loss and FCR rupture) while Gangopadhyay 2012 reported five different adverse effect categories (superficial radial nerve dysfunction, palmer cutaneous branch of median nerve dysfunction, FCR/pollicis longus pulling sensation, tendon scar and CRPS). It may be that adverse events were not reported even though they were assessed, but without confirmation in the published study's methods or results section, we cannot assume this. Furthermore, the inconsistent follow-up period in many studies gives a different perspective on the adverse events of any one procedure. For example, Gangopadhyay 2012 reported adverse events at one and five years post-operatively for each procedure. At one year follow-up, there were three fewer adverse events in the trapeziectomy (53 patients) group compared with the trapeziectomy with LRTI (54 patients) group. At the five year follow-up, there were four fewer complications in the trapeziectomy alone group compared with the trapeziectomy with LRTI group.

Overall completeness and applicability of evidence

We identified eight studies that included all of the commonly used surgical interventions (trapeziectomy, trapeziectomy with LRTI, trapeziectomy with IA, trapeziectomy with ligament reconstruction and trapeziometacarpal arthrodesis). We also identified three studies that involved implants, namely the Swanson implant and the Artelon implant. The former has fallen out of favour due to a high number of complications. The latter is not widely used and the only identified prospective comparative trials were manufacturer supported. Ten studies compared one technique against an another, while one study compared three surgical procedures (Gangopadhyay 2012). Ten studies were RCTs and one study was a controlled prospective pilot study (Nilsson 2005).
We did not find any studies comparing surgical techniques to sham surgery and we did not find any studies that compared surgery to conservative non-surgical interventions. Furthermore, we were unable to identify studies that compared many of our main outcomes between techniques. For example, in our main comparison (trapeziectomy alone to trapeziectomy with LRTI), we did not find any studies that compared patient quality of life, patient global assessment or treatment failure (reoperation) rates.
All or most patients in the included studies were female. This may limit the validity of this review for surgical treatment of males (particularly manual labourers) with trapeziometacarpal osteoarthritis.
We were also interested in examining the efficacy of surgical procedures in terms of the stage of trapeziometacarpal osteoarthritis (I-IV). However, ten trials were conducted on a mixed group of people with mostly stage III-IV trapeziometacarpal osteoarthritis and did not differentiate their results based on stage. Thus we were unable to conduct a subgroup analysis comparing outcomes between stages.
Based on this Cochrane Review, we are currently unable to make recommendations about the superiority of any one surgical procedure over another for a given stage of trapeziometacarpal osteoarthritis.

Quality of the evidence

Trapeziectomy with LRTI versus trapeziectomy alone

Due to the low quality of evidence, further research comparing these techniques using outcomes such as pain, physical function, adverse events and trapeziometacarpal joint imaging is very likely to have an important impact on our confidence in the estimate of effect and is likely to change our estimate. We downgraded the evidence due to unclear risk of bias in four or more areas in all included studies (downgraded by one) and because the total number of participants was less than 300 (imprecision, a threshold rule-of-thumb, GRADEpro 2014, downgraded by one).
The included studies that compared these two techniques did not report outcomes of quality of life, patient global assessment and treatment failure.

Trapeziectomy with LRTI versus trapeziectomy and ligament reconstruction

Due to the low quality of evidence, further research comparing these techniques using outcomes such as physical function, adverse events and trapeziometacarpal joint imaging is very likely to have an important impact on our confidence in the estimate of effect and is likely to change our estimate. We downgraded the evidence due to unclear risk of bias in four or more areas in all included studies (downgraded by one) and because total participant numbers were less than 300 (imprecision, a threshold rule-of-thumb, GRADEpro 2014, downgraded by one).
The included studies that compared these two techniques did not report the outcomes of pain, quality of life, patient global assessment and treatment failure.

Trapeziectomy with LRTI versus trapeziectomy and interpositional arthroplasty

Due to the moderate quality of evidence, further research comparing these techniques using the outcome of adverse events is likely to have an important impact on our confidence in the estimate of effect and may to change our estimate. We downgraded the evidence due to total participant numbers being less than 300 (imprecision, a threshold rule-of-thumb, GRADEpro 2014, downgraded by one).
The included studies did not report the outcomes of pain, physical function, quality of life, patient global assessment, treatment failure and trapeziometacarpal joint imaging.

Trapeziectomy with IA versus Artelon joint resurfacing

Due to the very low quality of evidence used in comparing these two techniques, we are uncertain of the benefits either technique has with regards to pain, adverse events or treatment failure over the other. We downgraded the evidence due either a high risk of selection bias (Nilsson 2005) or a high risk of attrition bias (Nilsson 2010) (downgraded by one), and total participant numbers being less than 300 (imprecision, a threshold rule-of-thumb, GRADEpro 2014, downgraded by one).
The included studies that compared these two techniques did not report the outcomes of physical function, quality of life, patient global assessment and trapeziometacarpal joint imaging.

Trapeziectomy with IA versus trapeziometacarpal joint replacement (Swanson)

Further research comparing these techniques using the outcome of adverse events is likely to have an important impact on our confidence in the estimate of effect and is likely to change our estimate. We downgraded the evidence due to unclear risk of bias in four or more areas in all included studies (downgraded by one) and because total participant numbers was less than 300 (imprecision, a threshold rule-of-thumb, GRADEpro 2014, downgraded by one).
The included studies that compared these two techniques did not report the outcomes of physical function, quality of life, patient global assessment, treatment failure and trapeziometacarpal joint imaging.

Trapeziectomy with IA versus trapeziectomy alone

Due to the moderate quality of evidence, further research comparing these techniques using the outcome of adverse events is likely to have an important impact on our confidence in the estimate of effect and may to change our estimate. We downgraded the evidence due to total participant numbers being less than 300 (imprecision, a threshold rule-of-thumb, GRADEpro 2014, downgraded by one).
The included studies that compared these two techniques did not report the outcomes of pain, physical function, quality of life, patient global assessment, treatment failure and trapeziometacarpal joint imaging.

Potential biases in the review process

We are confident that our detailed search strategy of the electronic databases and reference lists of published studies identified all relevant studies of surgery for trapeziometacarpal osteoarthritis.
One review author (IE) was an author of a paper we identified in the search (Edmunds 1994) but we excluded it as it contained no intervention of interest.

Agreements and disagreements with other studies or reviews

The findings of this review do not agree with our earlier reviews (Wajon 2005b; Wajon 2009). In the previous reviews, trapeziectomy with LRTI was associated with more adverse events than a simple trapeziectomy. This Cochrane Review demonstrates no significant difference in adverse events for trapeziectomy with LRTI compared to simple trapeziectomy. There are no additional disagreements in outcomes between this review and our previous reviews.

AUTHORS' CONCLUSIONS

Implications for practice

We did not find any studies comparing surgery to conservative therapy, and did not identify any comparing surgery to sham surgery. As a result, we cannot provide information about which treatment modality offers the best outcomes nor can we suggest

when is the right time to undertake surgery. In practice, surgery for trapeziometacarpal osteoarthritis is considered when conservative approaches fail and pain and dysfunction at the base of the thumb persist. Of the surgical options included, this systematic review has failed to identify any additional benefit in terms of pain, physical function, patient global assessment, strength, adverse events of any procedure over another. There was a statistically significant greater palmar abduction (in both degrees and centimetres) for trapeziectomy with LRTI group when compared to trapeziectomy alone group. There was no other statistically significant difference in range of motion in any other comparison conducted in this study.

The findings of this systematic review need to be considered in light of the fact that at least half the studies did not conceal the sequence of allocation. Further, it might be that other factors, such as the skill, experience and preference of an individual surgeon may have an effect in determining an individual's final clinical outcome.

Implications for research

Recently it was shown in a multi-centre randomised double-blinded control trial that knee arthroscopy provided no advantage over sham arthroscopy in the treatment of degenerative meniscal tears at a 12 month follow-up (Sihvonen 2013). Similar studies have demonstrated that we do not know what effect placebo, even in surgery, affects outcomes. We did not identify studies that compared sham surgery and another surgical technique and thus we do not true benefits surgery offers and is an area of potential research in the future.

There are a number of studies that provide similar results for our main comparison (trapeziectomy alone compared to trapeziectomy with LRTI). While we identified no difference in the outcomes of pain, physical function, patient global assessment and range of motion, all the results provided relatively large 95% CIs and thus we are uncertain if there are true differences between particular types of surgery. Future high quality, robust RCTs are needed to increase the precision of results and lower the average risk of bias across studies. Future studies should also compare new implants such as the Pi2 spacer (Bellemère 2011b) and polyvinal alcohol implant (Taleb 2014) against current techniques, to ensure comparable or better outcomes can be demonstrated and that patients do not experience the same complications that earlier implants that suffered before the implants are introduction into routine use.

These new robust RCTs that compare new techniques against current techniques should focus on patient outcomes, particularly pain, physical function (using a standardised questionnaire such as the DASH score) and adverse events. Outcomes, such as range of motion and strength, can be important for patient functioning but they can be covered by tools that measure physical function. New studies should also focus on reducing biases through strong methodological quality (Gummesson 2004) and authors should self-assess their study protocols using the CONSORT criteria (Sauerland 2004) prior to enrolling participants.

Grouping according to the stage of osteoarthritis in future studies is also desirable to allow decisions to be made about the most appropriate procedure for any given stage of osteoarthritis. However, we recognise that stage of osteoarthritis does not always correlate with symptoms such as pain. Furthermore, it is necessary that the standard 'simple' trapeziectomy performed by Belcher 2000 and De Smet 2004 be compared with the trapeziectomy with K wire fixation and six-week immobilisation performed by Gangopadhyay 2012, to determine whether there is any difference in outcome as a result of the K wire and prolonged immobilisation.

Future clinical studies should also focus on reducing biases through strong methodological quality (Gummesson 2004; Sauerland 2004). These studies should be randomised and include concealed allocation, blind outcome assessment, ITT analysis and consistent timing of outcome measures (such as, three months, and one and five years). They should also report outcomes as mean (SD) (or 95% CIs) of pre-intervention, post-intervention and change scores, and report the number of participants available at each occasion of measurement. Furthermore, satisfying the CONSORT 22-item checklist (Sauerland 2004) will enable readers to assess a clinical risk of bias and assess the validity of its results (Moher 2003). To aid comparability, outcome measures should include the following:

- Pain: using three subjective categories (no pain, pain with activity, pain at rest);
- Physical function: mean and range of an objective test such as the Disability of the Arm, Shoulder and Hand (DASH) questionnaire;
- Patient global assessment: health-related quality of life measure, such as the SF-36;
- Range of motion: mean and SD of the measurement of thumb trapeziometacarpal joint palmar abduction in degrees;
- Strength: mean and SD of grip strength in kg using the Jamar dynamometer with the handle in the second position, and pinch strength (two point, three point and lateral) in kg using the B & L® pinch gauge (B & L Engineering, Santa Fe Springs, CA 90670);
- Trapeziometacarpal joint imaging: mean and SD of scapho-metacarpal distance in millimetres at rest and during pinch;
- Adverse events: listed according to the following headings - scar tenderness; tendon rupture or adhesion (FCR); sensory changes; neuroma; CRPS (Type 1); and revision surgery.

ACKNOWLEDGEMENTS

We thank Professor Tim Davis, Dr Magnus Tagil and Mr J Field for providing further information about their studies. Also, we acknowledge Tamara Radar of the Musculoskeletal Cochrane Review Group for advice and help with the search strategy and searches. We thank Renea Johnston of the Musculoskeletal Cochrane Review Group for her editorial assistance and support.

REFERENCES

References to studies included in this review

Belcher 2000 *{published data only}*

Belcher HJ, Nicholl JE. A comparison of trapeziectomy with and without ligament reconstruction and tendon interposition. *Journal of Hand Surgery* 2000;**25**(4):350–6.

De Smet 2004 *{published data only}*

De Smet L, Sioen W, Spaepen D. Changes in key pinch strength after excision of the trapezium and total joint arthroplasty. *Journal of Hand Surgery* 2004;**29B**(1):40–1.

* De Smet L, Sioen W, Spaepen D, van Ransbeeck H. Treatment of basal joint arthritis of the thumb: trapeziectomy with or without tendon interposition/ ligament reconstruction. *Hand Surgery* 2004;**9B**(1):5–9.

De Smet L, Vanfleteren L, Sioen W, Spaepen D, Ransbeeck H. Ligament reconstruction/tendon interposition arthroplasty for thumb basal joint osteoarthritis preliminary results of a prospective outcome study. *Acta Orthoaedica Belgica* 2002;**68**(1):20–3.

Field 2007 *{published data only}*

Field J, Buchanan D. To suspend or not to suspend: a randomised single blind trial of simple trapeziectomy versus trapeziectomy and flexor carpi radialis suspension. *Journal of Hand Surgery* 2007;**32E**(4):462–6.

Gangopadhyay 2012 *{published data only}*

Davis TR, Brady O, Dias JJ. Excision of the trapezium for osteoarthritis of the trapeziometacarpal joint: a study of the benefit of ligament reconstruction or tendon interposition. *Journal of Hand Surgery* 2004;**29A**(6):1069–77.

Davis TRC, Brady O, Barton NJ, Lunn PG, Burke FD. Trapeziectomy alone, with tendon interposition or with ligament reconstruction. *Journal of Hand Surgery* 1997;**22B**(6):689–94.

* Gangopadhyay S, McKenna H, Burke FD, Davis TRC. Five- to 19-year follow-up for treatment of trapeziometacarpal osteoarthritis: A prospective comparison of excision, tendon interposition, and ligament reconstruction and tendon interposition. *Journal of Hand Surgery* 2012;**37A**(3):411–7.

Gerwin 1997 *{published data only}*

Gerwin M, Griffith A, Weiland AJ, Hotchkiss RN, McCormack RR. Ligament reconstruction basal joint arthroplasty without tendon interposition. *Clinical Orthopaedics and Related Research* 1997;**342**:42–5.

Hart 2006 *{published data only}*

Hart R, Janecek M, Siska V, Kucera B, Stipcák V. Interposition suspension arthroplasty according to Epping versus arthrodesis for trapeziometacarpal osteoarthritis. *European Surgery - Acta Chirurgica Austriaca* 2006;**38**(6):433–8.

Kriegs-Au 2004 *{published data only}*

Kriegs-Au G, Petje G, Fojtl E, Ganger R, Zachs I. Ligament reconstruction with or without tendon interposition to treat primary thumb carpometacarpal osteoarthritis. Surgical technique. *Journal of Bone and Joint Surgery* 2005;**87A**:78–85.

* Kriegs-Au G, Petje G, Fojtl E, Ganger R, Zachs I. Ligament reconstruction with or without tendon interposition to treat primary thumb carpometacarpal osteoarthritis: a prospective randomized study. *Journal of Bone and Joint Surgery* 2004;**86A**(2):209–18.

Nilsson 2005 *{published data only}*

Nilsson A, Liljensten E, Bergström C, Sollerman C. Results from a degradable TMC joint spacer (Artelon) compared with tendon arthroplasty. *Journal of Hand Surgery* 2005;**30A**(2):380–9.

Nilsson 2010 *{published data only}*

Nilsson A, Wiig M, Alnehill H, Berggren M, Björnum S, Geijer M, et al. The Artelon CMC spare compared with tendon interposition arthroplasty. *Acta Orthopaedica* 2010;**81**(2):237–44.

Salem 2012 *{published data only}*

Davis TRC, Pace A. Trapeziectomy for trapeziometacarpal joint osteoarthritis: is ligament reconstruction and temporary stabilisation of the pseudoarthrosis with a Kirschner wire important?. *Journal of Hand Surgery* 2009;**34E**(3):312–21.

* Salem H, Davis TRC. Six year outcome excision of the trapezium for trapeziometacarpal joint osteoarthritis: is it improved by ligament reconstruction and temporary Kirschner wire insertion?. *Journal of Hand Surgery* 2012;**37E**(3):211–9.

Tagil 2002 *{published data only}*

Tägil M, Adalberth K, Kopylov P. Swanson versus APL tendon arthroplasty in the treatment of osteoarthritis of the

first carpometacarpal joint: a prospective randomized study. *Journal of Hand Surgery* 1997;**22B**(Supplement 1):29.
* Tägil M, Kopylov P. Swanson versus APL arthroplasty in the treatment of osteoarthritis of the trapeziometacarpal joint: a prospective and randomized study in 26 patients. *Journal of Hand Surgery* 2002;**27B**(5):452–6.

References to studies excluded from this review

Abzug 2011 *{published data only}*
Abzug JM, Osterman AL. Arthroscopic hemiresection for stage II-III trapeziometacarpal osteoarthritis. *Hand Clinics* 2011;**27**(3):347–54.

Adams 1990 *{published data only}*
Adams BD, Unsell RS, McLaughlin P. Niebauer trapeziometacarpal arthroplasty. *Journal of Hand Surgery* 1990;**15A**(3):487–92.

Alnot 1998 *{published data only}*
Alnot J-Y, Muller G-P. A retrospective review of 115 cases of surgically-treated trapeziometacarpal osteoarthritis. *Revue du Rhumatisme (English edition)* 1998;**65**(2):95–108.

Amadio 1990 *{published data only}*
Amadio PC, De Silva SP. Comparison of the results of trapeziometacarpal arthrodesis and arthroplasty in men with osteoarthritis of the trapeziometacarpal joint. *Annales de Chirurgie de la Main et du Membre Supérieur* 1990;**9**(5): 358–63.

Angly 2006 *{published data only}*
Angly B, Steiger R, Stober R. Interposition arthroplasty for the treatment of primary osteoarthritis: comparison of results using the technique of Epping and Weilby. *Handchirurgie, Mikrochirurgie, Plastische Chirurgie* 2006;**38** (2):90–7.

Ardouin 2011 *{published data only}*
Ardouin L, Bellemère P. A five-year prospective outcome study of pi2 pyrocarbon arthroplasty for the treatment of thumb carpometacarpal joint osteoarthritis. *Chirurgie de la Main* 2011;**30**:S11–7.

Atroshi 1997 *{published data only}*
Atroshi I, Axelsson G. Extensor carpi radialis tendon arthroplasty in the treatment of primary trapeziometacarpal arthrosis. *Journal of Hand Surgery* 1997;**22A**(3):419–27.

Atroshi 1998 *{published data only}*
Atroshi I, Axelsson G, Nilsson E. Osteotomy versus tendon arthroplasty in trapeziometacarpal arthrosis: 17 patients followed for one year. *Acta Orthopaedica Scandinavica* 1998; **69**(3):287–90.

Bamberger 1992 *{published data only}*
Bamberger HB, Stern PJ, Kiefhaber TR, McDonough JJ, Cantor RM. Trapeziometacarpal joint arthrodesis: a functional evaluation. *Journal of Hand Surgery* 1992;**17A** (4):605–11.

Barron 1998 *{published data only}*
Barron OA, Eaton RG. Save the trapezium: double interposition arthroplasty for the treatment of stage IV disease of the basal joint. *Journal of Hand Surgery* 1998;**23A** (2):196–204.

Battiston 1997 *{published data only}*
Battiston B, Castelli P, Ferrari C, Ghiggio P, Nobile G, Tos P, et al. A comparative analysis of arthrodesis vs. suspension arthroplasty in the treatment of CM arthritis of the thumb. *Journal of Hand Surgery* 1997;**22B**(Supplement 1):45.

Belcher 2001 *{published data only}*
Belcher H, Zic R. Adverse effect of porcine collagen interposition after trapeziectomy: a comparative study. *Journal of Hand Surgery* 2001;**26B**(2):159–64.

Beldame 2010 *{published data only}*
Beldame J, Desmoineaux P, Le Moulec YP, Lintz F, Duparc F. Arthroscopic partial trapeziectomy. A radio-anatomical study about 14 cases. *Chirurgie de la Main* 2010;**29**(3): 188–94.

Bellemère 2011a *{published data only}*
Bellemère P, Gaisne P, Loubersac T, Ardouin L, Collon S, Maes C. Pyrocardan implant: Free pyrocarbon interposition for resurfacing trapeziometacarpal joint. *Chirurgie de la Main* 2011;**30**:S28–35.

Berggren 2001 *{published data only}*
Berggren M, Joost-Davidsson A, Lindstrand J, Nylander G, Povlsen B. Reduction in the need for operation after conservative treatment of osteoarthritis of the first carpometacarpal joint: a seven year prospective study. *Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery* 2001;**35**(4):415–7.

Bezwada 2002 *{published data only}*
Bezwada HP, Sauer ST, Hankins ST, Webber JB. Long-term results of trapeziometacarpal silicone arthroplasty. *Journal of Hand Surgery* 2002;**27**(3):409–17.

Brand 2007 *{published data only}*
Brand J, Zeichen J, Gaulke R. Suspension arthroplasty of the thumb carpometacarpal joint in different views - a questionnaire. *Handchirurgie, Mikrochirurgie, Plastische Chirurgie* 2007;**39**(4):267–71.

Braun 1982 *{published data only}*
Braun R. Total joint replacement at the base of the thumb-preliminary report. *Journal of Hand Surgery* 1982;**7A**(3): 245–51.

Brunton 2011 *{published data only}*
Brunton LM, Wittstadt RA. Thumb carpometacarpal arthroplasty using an absorbable interference screw for flexor carpi radialis ligament reconstruction. *Techniques in Hand & Upper Extremity Surgery* 2011;**15**(2):115–8.

Budoff 2002 *{published data only}*
Budoff JE, Leonard G. Long-term results of tendon shortening trapeziometacarpal arthoplasty. *Clinical Orthopaedics and Related Research* 2002;**405**:199–206.

Burton 1973 *{published data only}*
Burton RI. Basal joint arthrosis of the thumb. *Orthopaedic Clinics of North America* 1973;**4**(2):331–48.

Burton 1986 *{published data only}*
Burton RI, Pellegini VD Jr. Surgical management of basal joint arthritis of the thumb. Part II. Ligament reconstruction with tendon interposition arthroplasty. *Journal of Hand Surgery* 1986;**11A**(3):324–32.

Burton 1987 *{published data only}*
Burton R. Basal joint implant arthoplasty in osteoarthritis. Indications, techniques, pitfalls, and problems. *Hand Clinics* 1987;**3**(4):473–85.

Camus 2000 *{published data only}*
Camus E, Farez E, Rtaimate M, Millot F, Bouretz J-C. Surgical treatment of carpometacarpal osteoarthritis of the thumb by trapeziectomy-ligament reconstruction with tendon interposition arthroplasty. *Chirurgie de la Main* 2000;**19**(1):36–43.

Caputo 1993 *{published data only}*
Caputo RJ, Bennett JB. Power staple fixation in trapeziometacarpal arthrodesis. *Journal of Hand Surgery* 1993;**18A**(5):926–9.

Carneiro 2007 *{published data only}*
Carneiro R, Dini R, Radi-Peters C. Base of the thumb arthoplasty with suspension: a double blind prospective comparison of two techniques. IFSSH & IFSHT Conference; 2007 March 11-15; Sydney. 2007:138.

Carroll 1987 *{published data only}*
Carroll RE. Arthrodesis of the carpometacarpal joint of the thumb. A review of patients with a long postoperative period. *Clinical Orthopaedics and Related Research* 1987; **220**:106–10.

Chakrabarti 1997 *{published data only}*
Chakrabarti A, Robinson AH, Gallagher P. De la Caffinière thumb carpometacarpal replacements. 93 cases at 6 to 16 years follow-up. *Journal of Hand Surgery* 1997;**22B**(6): 695–8.

Chamay 1994 *{published data only}*
Chamay A, Piaget-Morerod F. Arthrodesis of the trapeziometacarpal joint. *Journal of Hand Surgery* 1994;**19B** (4):489–97.

Clough 1990 *{published data only}*
Clough DA, Crouch CC, Bennett JB. Failure of trapeziometacarpal arthrodesis with use of the Herbert screw and limited immobilization. *Journal of Hand Surgery* 1990;**15A**(5):706–11.

Conolly 1989 *{published data only}*
Conolly W, Rath S, Herbert T. The complications of surgery for osteoarthritis of the basal joint of the thumb and revision procedures. 4th Congress of the International Federation of Societies for Surgery of the Hand (ISSH); 1989 April 9-14; Tel-Aviv, Israel. 1989:6.

Conolly 1993 *{published data only}*
Conolly W, Lanzetta M. Surgical management of arthritis of the carpo-metacarpal joint of the thumb. *Australian and New Zealand Journal of Surgery* 1993;**63**(8):596–603.

Cox 2010 *{published data only}*
Cox CA, Zlotolow DA, Yao J. Suture button suspensionplasty after arthroscopic hemitrapeziectomy for treatment of thumb carpometacarpal arthritis. *Arthroscopy* 2010;**26**(10):1395–403.

Creamer 1998 *{published data only}*
Creamer P, Flores R, Hochberg MC. Management of osteoarthritis in older adults. *Clinics in Geriatric Medicine* 1998;**14**(3):435–54.

Cristiani 1997 *{published data only}*
Cristiani G, Marcuzzi A, Marcialis M, Castagnini L, Caroli A. Partial trapeziectomy, ligament reconstruction and interpositional arthroplasty for trapeziometacarpal arthritis of the thumb. *Journal of Hand Surgery* 1997;**22B** (Supplement 1):30.

Dacatra 2001 *{published data only}*
Dacatra U, Torretta F. Experience with "Sr" prosthesis in trapeziometacarpal arthritis. 8th Congress of the International Federation of Societies for Surgery of the Hand (ISSH); 2001 June 10-14; Istanbul, Turkey. 2001.

Damen 1997 *{published data only}*
Damen A, van der Lei B, Robinson PH. Bilateral osteoarthritis of the trapeziometacarpal joint treated by bilateral tendon interposition arthroplasty. *Journal of Hand Surgery* 1997;**22B**(1):96–9.

Damen 2000 *{published data only}*
Damen A, van der Lei B, Schepel S, den Dunnen WFA, Robinson PH. Poor results of distal trapezium resection for trapeziometacarpal-1 osteoarthritis. *European Journal of Plastic Surgery* 2000;**23**(4):227–31.

Damen 2001 *{published data only}*
Damen A, Dijkstra T, van der Lei B, den Dunnen WF, Robinson PH. Long-term results of arthrodesis of the carpometacarpal joint of the thumb. *Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery* 2001; **35**(4):407–13.

Day 2004 *{published data only}*
Day CS, Gelberman R, Patel AA, Vogt MT, Ditsios K, Boyer MI. Basal joint osteoarthritis of the thumb: a prospective trial of steroid injection and splinting. *Journal of Hand Surgery* 2004;**29**(2):247–51.

Dell 1978 *{published data only}*
Dell PC, Brushart TM, Smith RJ. Treatment of trapeziometacarpal arthritis: results of resection arthroplasty. *Journal of Hand Surgery* 1978;**3**(3):243–9.

Dhar 1994 *{published data only}*
Dhar S, Gray ICM, Jones WA, Beddow FH. Simple excision of the trapezium for osteoarthritis of the carpometacarpal joint of the thumb. *Journal of Hand Surgery* 1994;**19B**(4): 485–8.

Dodaro 1999 *{published data only}*
Dodaro G, Corbella M, Sala C, Pasquini A, Colombo E. De La Caffiniere cemented arthroplasty in isolated trapeziometacarpal osteoarthritis. A review of 14 clinical cases treated from 1991 to 1997. *Minerva Ortopedica e Traumatologica* 1999;**50**(3):93–6.

Eaton 1979 *{published data only}*
Eaton RG. Replacement of the trapezium for arthritis of the basal articulations: a new technique with stabilization by tenodesis. *Journal of Bone and Joint Surgery* 1979;**61A**(1): 76–82.

Eaton 1984 *{published data only}*
Eaton RG, Lane LB, Littler JW, Keyser JJ. Ligament reconstruction for the painful thumb carpometacarpal joint: a long-term assessment. *Journal of Hand Surgery* 1984;**9A** (5):692–9.

Eaton 1985 *{published data only}*
Eaton RG, Glickel SZ, Littler JW. Tendon interposition arthroplasty for degenerative arthritis of the trapeziometacarpal joint of the thumb. *Journal of Hand Surgery* 1985;**10**(5):645–53.

Edmunds 1994 *{published data only}*
Edmunds I, Trevithick B, Honner R. Fusion of the first metacarpophalangeal joint for post-traumatic conditions. *Australian and New Zealand Journal of Surgery* 1994;**64**(11): 771–4.

Egloff 2002 *{published data only}*
Egloff D. Surgery of the carpometacarpal joint of the first ray. *Journal of Hand Surgery* 2002;**27B**(Supplement 1):26.

Eiken 1970 *{published data only}*
Eiken O, Carstam N. Functional assessment of basal joint fusion of the thumb. *Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery* 1970;**4**(2):122–5.

Esenwein 2011 *{published data only}*
Esenwein P, Hoigne D, Zdravkovic V, Sanchez T. Resection, interposition and suspension arthroplasty for treatment of basal joint arthritis of the thumb: a randomized and prospective comparison of techniques using the abductor pollicis longus- and the flexor carpi radialis tendon. *Handchirurgie, Mikrochirurgie, Plastische Chirurgie* 2011;**43** (5):289–94.

Ferlic 1983 *{published data only}*
Ferlic DC, Turner BD, Clayton ML. Compression arthrodesis of the thumb. *Journal of Hand Surgery* 1983;**8** (2):207–10.

Forseth 2003 *{published data only}*
Forseth MJ, Stern PJ. Complications of trapeziometacarpal arthrodesis using plate and screw fixation. *Journal of Hand Surgery* 2003;**28**(2):342–5.

Froimson 1987 *{published data only}*
Froimson AI. Tendon interposition arthroplasty of carpometacarpal joint of the thumb. *Hand Clinics* 1987;**3** (4):489–503.

Fujiwara 2003 *{published data only}*
Fujiwara M, Haraoka G, Sumiya A. Extension metacarpal osteotomy in the treatment of carpometacarpal osteoarthrosis of the thumb. *Japanese Journal of Plastic and Reconstructive Surgery* 2003;**46**(1):95–103.

Fulton 2001 *{published data only}*
Fulton DB, Stern PJ. Trapeziometacarpal arthrodesis in primary osteoarthritis: a minimum two year follow-up study. *Journal of Hand Surgery* 2001;**26A**(1):109–14.

Furia 2010 *{published data only}*
Furia JP. Arthroscopic debridement and synovectomy for treating basal joint arthritis. *Arthroscopy* 2010;**26**(1):34–40.

Galli 2002 *{published data only}*
Galli S, Megaro A, Filippo GD, Codato F, Pazzaglia U. Arthrodesis versus suspension arthroplasty in the treatment of carpometacarpal arthritis of the thumb. *Journal of Hand Surgery* 2002;**27B**(Supplement 1):26.

Gallinet 2011 *{published data only}*
Gallinet D, Gasse N, Blanchet N, Tropet Y, Obert L. Osteoarthritis of the trapeziometacarpal joint in men: different stakes. *Chirurgie de la Main* 2011;**30**(1):40–5.

Gangopadhyay 2008 *{published data only}*
Gangopadhyay S, Davis TRC. Advances in treatment of basal joint arthritis of the thumb. *Current Orthopaedics* 2008;**19**(5):503–508.

García-Mas 2009 *{published data only}*
García-Mas R, Solé Molins X. Partial trapeziectomy with ligament reconstruction - tendon interposition in thumb carpo-metacarpal osteoarthritis. A study of 112 cases [La trapézectomie partielle avec ligamentoplastie et interposition dansla rhizarthrose. Étude sur 112 cas]. *Chirurgie de la Main* 2009;**28**(4):230–8.

Gibbons 1999 *{published data only}*
Gibbons CE, Gosal HS, Choudri AH, Magnussen PA. Trapeziectomy for basal thumb joint osteoarthritis: 3- to 19-year follow-up. *International Orthopaedics* 1999;**23**(4): 216–8.

Goldberg 1994 *{published data only}*
Goldberg I, Amit S, Peylan J, Adler A. Tendon interposition arthroplasty vs Kessler silicone prosthesis for basal joint arthritis of the thumb. *Harefuah* 1994;**126**(12):696–9.

Gray 2007 *{published data only}*
Gray KV, Meals RA. Hematoma and distraction arthroplasty for thumb basal joint osteoarthritis: minimum 6.5-year follow-up evaluation. *Journal of Hand Surgery* 2007;**32A**(1): 23–9.

Haase 2011 *{published data only}*
Haase SC, Chung KC. An evidence-based approach to treating carpometacarpal joint arthritis. *Plastic and Reconstructive Surgery* 2011;**127**(2):918–25.

Hannula 1999 *{published data only}*
Hannula TT, Nahigian SH. A preliminary report: cementless trapeziometacarpal arthroplasty. *Journal of Hand Surgery* 1999;**24**(1):92–101.

Harrison 1977 *{published data only}*
Harrison S, Smith R, Maxwell D. Stabilization of the first metacarpophalangeal and terminal joints of the thumb. *The Hand* 1977;**9**(3):242–9.

Hartigan 2001 *{published data only}*
Hartigan BJ, Stern PJ, Kiefhaber TR. Thumb carpometacarpal osteoarthritis: arthrodesis compared with ligament reconstruction and tendon interposition. *Journal of Bone and Joint Surgery* 2001;**83A**(10):1470–8.

Hass 1989 *{published data only}*
Hass A, Baruch A. Silicon CMC arthroplasty versus trapeziectomy. 4th Congress of the International Federation of Societies for Surgery of the Hand; 1989 April 9-14; Tel-Aviv, Israel. 1989:14.

Hernández-Cortes 2012 *{published data only}*
Hernández-Cortés P, Pajeres-López M, Robles-Molina M, Gómez-Sánchez R, Toledo-Romero MA, de Torres-Urrea J. Two-year outcomes of Elektra prosthesis for trapeziometacarpal osteoarthritis: a longitudinal cohort study. *Journal of Hand Surgery* 2012;**37E**(2):130–7.

Herren 1997 *{published data only}*
Herren D, Simmen B. The resection-suspension-interposition-arthroplasty for the treatment of peritrapezial arthritis. *Journal of Hand Surgery* 1997;**22B**(Supplement 1):29.

Hilty 1996 *{published data only}*
Hilty M, Stober R. Results of trapeziectomy and suspension arthroplasty according to Epping. *Handchirurgie, Mikrochirurgie, Plastische Chirurgie* 1996;**28**(1):15–21.

Hobby 1998 *{published data only}*
Hobby J, Lyall HA, Meggitt BF. First metacarpal osteotomy for trapeziometacarpal osteoarthritis. *Journal of Bone and Joint Surgery* 1998;**80B**(3):508–12.

Hofammann 1987 *{published data only}*
Hofammann DY, Ferlic DC, Clayton ML. Arthroplasty of the basal joint of the thumb using a silicone prosthesis. Long term follow-up. *Journal of Bone and Joint Surgery* 1987;**69A**(7):993–7.

Hohendorff 2008 *{published data only}*
Hohendorff B, Staub L, Kaiser T, von Wartburg U. Working ability after tendon interposition arthroplasty for degenerative arthritis of the thumb trapeziometacarpal joint. *Handchirurgie, Mikrochirurgie, Plastische Chirurgie* 2008;**40**(3):175–81.

Hollevoet 1996 *{published data only}*
Hollevoet N, Kinnen L, Moermans JP, Ledoux P. Excision of the trapezium for osteoarthritis of the trapeziometacarpal joint of the thumb. *Journal of Hand Surgery* 1996;**21B**(4): 458–62.

Holmberg 1996 *{published data only}*
Holmberg J, Lundborg G. Osteotomy of the first metacarpal for osteoarthrosis of the basal joints of the thumb. *Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery* 1996;**30**(1):67–70.

Horlock 2002 *{published data only}*
Horlock N, Belcher HJ. Early versus late mobilisation after simple excision of the trapezium. *Journal of Bone and Joint Surgery* 2002;**84**(8):1111–5.

Isselin 2001 *{published data only}*
Isselin J. Results of the "ARPE" trapeziometacarpal prosthesis. *Chirurgie de la Main* 2001;**20**(1):89–92.

Johnston 2012 *{published data only}*
Johnston P, Getgood A, Larson D, Chonjnowski A, Chakrabarti A, Chapman PG. De la Caffinière thumb trapeziometacarpal joint arthroplasty: 16-26 year follow-up. *Journal of Hand Surgery* 2012;**37E**(7):621–4.

Jörheim 2009 *{published data only}*
Jörheim M, Isaxon I, Flondell M, Kalén P, Atroshi I. Short-term outcomes of trapeziometacarpal Artelon implant compared with tendon suspension interposition arthroplasty for osteoarthritis: a matched cohort study. *Journal of Hand Surgery* 2009;**34A**(8):1381–7.

Kaarela 1999 *{published data only}*
Kaarela O, Raatikainen T. Abductor pollicis longus tendon interposition arthroplasty for carpometacarpal osteoarthritis of the thumb. *Journal of Hand Surgery* 1999;**24**(3):469–75.

Kapandji 2002 *{published data only}*
Kapandji AI, Heim UF. Reorientation osteotomy of the trapezial saddle. *Chirurgie de la Main* 2002;**21**(2):124–33.

Karlsson 1990 *{published data only}*
Karlsson M. Arthrodesis of the trapeziometacarpal joint. *Scandinavian Journal of Plastic and Reconstructive Hand Surgery* 1990;**25**(2):167–71.

Kaszap 2012 *{published data only}*
Kaszap B, Daecke W, Jung M. High frequency failure of the Moje thumb carpometacarpal joint arthroplasty. *Journal of Hand Surgery* 2012;**37E**(7):610–6.

Kenniston 2008 *{published data only}*
Kenniston JA, Bozentka DJ. Treatment of advanced carpometacarpal joint disease: arthrodesis. *Hand Clinics* 2008;**24**(3):285–94.

Kleinman 1991 *{published data only}*
Kleinman WB, Eckenrode JF. Tendon suspension sling arthroplasty for thumb trapeziometacarpal arthritis. *Journal of Hand Surgery* 1991;**16A**(6):983–91.

Kocheva 2011 *{published data only}*
Kocheva AJ, Adham CN, Adham MN, Angel MF, Walkinshaw MD. Thumb basal joint arthroplasty using abductor pollicis longus tendon: an average of 5.5 year follow-up. *Journal of Hand Surgery* 2011;**36A**(8):1326–32.

Köhler 1987 *{published data only}*
Köhler L, Brüser P, Noever G, Schmider-Rauschendorfer M, Troidl H. Long-term results following resection arthroplasty and prosthesis implantation in idiopathic saddle joint arthrosis. *Handchirurgie, Mikrochirurgie, Plastische Chirurgie* 1987;**19**(4):206–9.

Kokkalis 2009 *{published data only}*
Kokkalis ZT, Zanaros G, Sotereanos DG. Ligament reconstruction with tendon interposition using an acellular dermal allograft for thumb carpometacarpal arthritis. *Techniques in Hand & Upper Extremity Surgery* 2009;**13**(1): 41–6.

Kuhns 2003 *{published data only}*
Kuhns CA, Emerson ET, Meals RA. Hematoma and distraction arthroplasty for thumb basal joint osteoarthritis: a prospective, single-surgeon study including outcome measures. *Journal of Hand Surgery* 2003;**28A**(3):381–9.

Kuschner 1996 *{published data only}*
Kuschner SH, Lane CS. Surgical treatment for osteoarthritis at the base of the thumb. *American Journal of Orthopedics* 1996;**25**(2):91–100.

Lane 1987 *{published data only}*
Lane LB, Eaton RG. Ligament reconstruction for the painful "prearthritic" thumb carpometacarpal joint. *Clinical Orthopaedics and Related Research* 1987;**220**:52–7.

Lane 2001 *{published data only}*
Lane LB, Henley DH. Ligament reconstruction of the painful, unstable, nonarthritic thumb carpometacarpal joint. *Journal of Hand Surgery* 2001;**26**(4):686–91.

Lanzetta 1995 *{published data only}*
Lanzetta M, Foucher G. A comparison of different surgical techniques in treating degenerative arthrosis of the carpometacarpal joint of the thumb. A retrospective study of 98 cases. *Journal of Hand Surgery* 1995;**20B**(1):105–10.

Lehmann 1998 *{published data only}*
Lehmann O, Herren DB, Simmen BR. Comparison of tendon suspension-interposition and silicon spacers in the treatment of degenerative osteoarthritis of the base of the thumb. *Annales de Chirurgie de la Main et du Membre Supérieur* 1998;**17**(1):25–30.

Le Viet 1996 *{published data only}*
Le Viet DT, Kerboull L, Lantieri LA, Collins DE. Stabilized resection arthroplasty by an anterior approach in trapeziometacarpal arthritis: results and surgical technique. *Journal of Hand Surgery* 1996;**21**(2):194–201.

Li 2011 *{published data only}*
Li YK, White C, Ignacy TA, Thoma A. Comparison of trapeziectomy and trapeziectomy with ligament reconstruction and tendon interposition: a systematic literature review. *Plastic and Reconstructive Surgery* 2011; **128**(1):199–207.

Lins 1996 *{published data only}*
Lins RE, Gelberman RH, McKeown L, Katz JN, Kadiyala RK. Basal joint arthritis: trapeziectomy with ligament reconstruction and tendon interposition arthroplasty. *Journal of Hand Surgery* 1996;**21**(2):202–9.

Linscheid 2000 *{published data only}*
Linscheid RL. Implant arthroplasty of the hand: retrospective and prospective considerations. *Journal of Hand Surgery* 2000;**25A**(5):796–816.

Lisanti 1997 *{published data only}*
Lisanti M, Rosati M, Spagnolli G, Luppichini G. Trapeziometacarpal joint arthrodesis for osteoarthritis. Results of power staple fixation. *Journal of Hand Surgery* 1997;**22B**(5):576–9.

Liu 1999 *{published data only}*
Liu Y, Chang M-C. Ligament reconstruction and tendon interpositional arthroplasty for degenerative arthritis of the thumb trapeziometacarpal joint. *Chinese Medical Journal (Taipei)* 1999;**62**(11):795–800.

Lovell 1999 *{published data only}*
Lovell ME, Nuttall D, Trail IA, Stilwell J, Stanley JK. A patient-reported comparison of trapeziectomy with Swanson Silastic implant or sling ligament reconstruction. *Journal of Hand Surgery* 1999;**24B**(4):453–5.

MacDermid 2003 *{published data only}*
MacDermid JC, Roth JH, Rampersaud YR, Bain GI. Trapezial arthroplasty with silicone rubber implantation for advanced osteoarthritis of the trapeziometacarpal joint of the thumb. *Canadian Journal of Surgery* 2003;**46**(2): 103–10.

Mandl 2006 *{published data only}*
Mandl LA, Hotchkiss RN, Adler RS, Ariola LA, Katz JN. Can the carpometacarpal joint be injected accurately in the office setting? Implications for therapy. *Journal of Rheumatology* 2006;**33**(6):1137–9.

Marmor 1969 *{published data only}*
Marmor L, Peter JB. Osteoarthritis of the carpometacarpal joint of the thumb. *American Journal of Surgery* 1969;**117** (5):632–6.

Marmor 1972 *{published data only}*
Marmor L. Surgery of osteoarthritis. *Seminars in arthritis and rheumatism* 1972;**2**(2):117–56.

Marti 2006 *{published data only}*
Marti RK, Schröder J. Arthrodesis of small joint, illustrated by the carpometacarpal joint of the thumb. *Operative Orthopadie und Traumatologie* 2006;**18**(1):57–65.

Martinez de Aragon 2009 *{published data only}*
Martinez de Aragon JS, Moran SL, Rizzo M, Reggin KB, Beckenbaught RD. Early outcomes of pyrolytic carbon hemi-arthroplasty for the treatment of trapezial-metacarpal arthritis. *Journal of Hand Surgery* 2009;**34A**(2):205–12.

Masmejean 2003 *{published data only}*
Masmejean E, Alnot JY, Chantelot C, Beccari R. Guepar anatomical trapeziometacarpal arthroplasty prosthesis. *Chirurgie de la Main* 2003;**22**(1):30–6.

McGovern 2001 *{published data only}*
McGovern RM, Shin AY, Beckenbaugh RD, Linscheid RL. Long-term results of cemented Steffee arthroplasty of the thumb metacarpophalangeal joint. *Journal of Hand Surgery* 2001;**26**(1):115–22.

Menon 1995 *{published data only}*
Menon J. Partial trapeziectomy and interpositional arthroplasty for trapeziometacarpal osteoarthritis of the thumb. *Journal of Hand Surgery* 1995;**20B**(5):700–6.

Mentzel 2001 *{published data only}*
Mentzel M, Ebinger T, Heckmann E, Merk SE, Kinzl L, Wachter NJ. Results of treatment of basal joint arthrosis of the thumb - comparison of ligament reconstruction according to Epping and simple trapeziectomy.

Handchirurgie, Mikrochirurgie, Plastische Chirurgie 2001;**33**(3):176–80.

Messina 2000 ***{published data only}***
Messina A. Vascularized surgical rotation of a bi-articular trapezoid-trapeziometacarpal complex for the treatment of severe rhizarthrosis of the thumb. *Chirurgie de la Main* 2000;**19**(2):134–40.

Messina 2002 ***{published data only}***
Messina A, Messina J. Treatment of severe degenerative arthritis of the basal joint of the thumb by the vascularized rotatory transfer of the trapezoid-trapezium-metacarpal bi-articular complex. *Journal of Hand Surgery* 2002;**27B** (Supplement 1):26.

Mo 2004 ***{published data only}***
Mo JH, Gelberman RH. Ligament reconstruction with trapezium retention arthroplasty for carpometacarpal arthritis. *Journal of Hand Surgery* 2004;**29A**(2):240–6.

Molitor 1991 ***{published data only}***
Molitor P, Emery R, Meggitt B. First metacarpal osteotomy for carpometacarpal osteoarthritis. *Journal Hand Surgery* 1991;**16B**(4):424–7.

Muermans 1998 ***{published data only}***
Muermans S, Coenen L. Interpositional arthroplasty with Gore-Tex, Marlex or tendon for osteoarthritis of the trapeziometacarpal joint. A retrospective comparative study. *Journal of Hand Surgery* 1998;**23B**(1):64–8.

Mureau 2001 ***{published data only}***
Mureau MA, Rademaker RP, Verhaar JA, Hovius SE. Tendon interposition arthroplasty versus arthrodesis for the treatment of trapeziometacarpal arthritis: a retrospective comparative follow-up study. *Journal of Hand Surgery* 2001; **26A**(5):869–76.

Nakajima 1996 ***{published data only}***
Nakajima H, Masada K, Ohno H, Shinmei M. A new arthroplasty of the basal joint of the thumb using a silicone ball. *Journal of Orthopaedic Surgery* 1996;**4**(1):61–6.

Nilsson 2002 ***{published data only}***
Nilsson A, Stefansson E, Sollerman C. A new spacer with joint stabilization for arthroplasty of the CMC-I joint. One year follow-up results. *Journal of Hand Surgery* 2002;**27B** (Supplement 1):26.

Nordback 2012 ***{published data only}***
Nordback S, Erba P, Wehrli L, Raffoul W, Egloff DV. Trapeziectomy and tendon suspension with or without a Mitek anchor fixation in the thumb basal joint osteoarthritis. *Journal of Hand Surgery* 2012;**37E**(7):625–31.

Nusem 2003 ***{published data only}***
Nusem I, Goodwin DR. Excision of the trapezium and interposition arthroplasty with gelfoam for the treatment of trapeziometacarpal osteoarthritis. *Journal of Hand Surgery* 2003;**28B**(3):242–5.

Nylén 1993 ***{published data only}***
Nylén S, Johnson A, Rosenquist A-M. Trapeziectomy and ligament reconstruction for osteoarthrosis of the base of the thumb. A prospective study of 100 operations. *Journal of Hand Surgery* 1993;**18B**(5):616–9.

O'Leary 1997 ***{published data only}***
O'Leary S, Grobbelaar M, Goldsmith N, Smith P, Harrison S. Trapeziometacarpal arthritis: a review of the Helal silicone rubber ball spacer. *Journal of Hand Surgery* 1997; **22B**(Supplement 1):45.

O'Leary 2002 ***{published data only}***
O'Leary ST, Grobbelaar AO, Goldsmith N, Smith PJ, Harrison DH. Silicone arthroplasty for trapeziometacarpal arthritis. *Journal of Hand Surgery* 2002;**27B**(5):457–61.

Oka 2000 ***{published data only}***
Oka Y, Ikeda M. Silastic interposition arthroplasty for osteoarthrosis of the carpometacarpal joint of the thumb. *Tokai Journal of Experimental and Clinical Medicine* 2000; **25**(1):15–21.

Panciera 1997 ***{published data only}***
Panciera C, Panciera P. Wilson's wedge osteotomy and arthrodesis in first carpometacarpal osteoarthritis: comparisons of two procedures. *Journal of Hand Surgery* 1997;**22B**(Supplement 1):30.

Pellegrini 1986 ***{published data only}***
Pellegrini VD Jr, Burton RI. Surgical management of basal joint arthritis of the thumb. Part 1. Long-term results of silicone implant arthroplasty. *Journal of Hand Surgery* 1986; **11A**(3):309–32.

Pellegrini 1996 ***{published data only}***
Pellegrini VD Jr, Parentis M, Judkins A, Olmstead J, Olcott C. Extension metacarpal osteotomy in the treatment of trapeziometacarpal osteoarthritis: a biomechanical study. *Journal of Hand Surgery* 1996;**21**(1):16–23.

Pérez-Úbeda 2003 ***{published data only}***
Pérez-Úbeda M-J, García-López A, Martinez FM, Junyent Vilanova E, Molina Martos M, López-Duran Stern L. Results of the cemented SR trapeziometacarpal prosthesis in the treatment of thumb carpometacarpal osteoarthritis. *Journal Hand Surgery* 2003;**28**(6):917–25.

Phaltankar 2003 ***{published data only}***
Phaltankar P, Magnussen P. Hemiarthroplasty for trapeziometacarpal arthritis - a useful alternative?. *Journal Hand Surgery* 2003;**28B**(1):80–5.

Punzi 2012 ***{published data only}***
Punzi L, Frallonardo P, Campana C, Ramonda R. State of the art in managing hand osteoarthritis. *Osteoarthritis and Cartilage* 2012;**20**:S6–S7.

Rab 2006 ***{published data only}***
Rab M, Gohritz A, Gohla T, Krimmer H, Lanz U. Long term results after resection arthroplasty in patients with arthrosis of the thumb carpometacarpal joint: comparison of abductor pollicis longus and flexor carpi radialis tendon suspension. *Handchirurgie, Mickrochirurgie, Plastische Chirurgie* 2006;**38**(2):98–103.

Raven 2007 ***{published data only}***
Raven EEJ, Kerkhoffs GMMJ, Rutten S, Marsman AJW, Marti RK, Albers GHR. Long term results of surgical

intervention for osteoarthritis of the trapeziometacarpal joint: comparison of resection arthroplasty, trapeziectomy with tendon interposition and trapezio-metacarpal arthrodesis. *International Orthopaedics* 2007;**31**(4):547–54.

Rayan 1997 ***{published data only}***
Rayan GM, Young BT. Ligament reconstruction arthroplasty for trapeziometacarpal arthrosis. *Journal Hand Surgery* 1997;**22A**(6):1067–76.

Ritchie 2008 ***{published data only}***
Ritchie JFS, Belcher HJCR. A comparison of trapeziectomy via anterior and posterior approaches. *Journal of Hand Surgery* 2008;**33**(2):137–43.

Roberts 2001 ***{published data only}***
Roberts RA, Jabaley ME, Nick TG. Results following trapeziometacarpal arthroplasty of the thumb. *Journal Hand Therapy* 2001;**14**(3):202–7.

Robinson 1991 ***{published data only}***
Robinson D, Aghasi M, Halperin N. Abductor pollicis longus tendon arthroplasty of the trapezio-metacarpal joint: surgical technique and results. *Journal Hand Surgery* 1991; **16A**(3):504–9.

Saehle 2002 ***{published data only}***
Saehle T, Sande S, Finsen V. Abductor pollicis longus tendon interposition for arthrosis in the first carpometacarpal joint: 55 thumbs reviewed after 3 (1-5) years. *Acta Orthopaedica Scandinavica* 2002;**73**(6):674–7.

Sakellarides 1989 ***{published data only}***
Sakellarides H. The treatment of osteoarthritis of the carpometacarpal joint of the thumb. 4th Congress of the International Federation of Societies for Surgery of the Hand (ISSH); 1989 April 9-14; Tel-Aviv, Israel. 1989:41.

Sammer 2010 ***{published data only}***
Sammer DM, Amadio PC. Description and outcomes of a new technique for thumb basal joint arthroplasty. *Journal of Hand Surgery* 2010;**35**(7):1198–205.

Sandvall 2010 ***{published data only}***
Sandvall BK, Cameron TE, Netscher DT, Epstein MJ, Staines KG, Petersen NJ. Basal joint osteoarthritis of the thumb: ligament reconstruction and tendon interposition versus hematoma distraction arthroplasty. *Journal of Hand Surgery* 2010;**35A**(12):1968–75.

Schmidt 1993 ***{published data only}***
Schmidt K, Schneider KS, Miehlke RK. Medium-term results of Silastic™ hemiarthroplasty of the CMC-I joint according to Swanson. *Aktuelle Rheumatologie* 1993;**18**(5): 143–9.

Schröder 2002 ***{published data only}***
Schröder J, Kerkhoffs GMMJ, Voerman HJ, Marti RK. Surgical treatment of basal joint disease of the thumb: comparison between resection-interposition arthroplasty and trapezio-metacarpal arthrodesis. *Archives of Orthopaedic and Trauma Surgery* 2002;**122**(1):35–8.

Schuhl 2001 ***{published data only}***
Schuhl JF. The Roseland prosthesis in the trapeziometacarpal arthritis. A five years experience with the same operator. *Chirurgie de la Main* 2001;**20**(1):75–8.

Smíd 2001 ***{published data only}***
Smíd L, Janecka T. Surgical treatment of osteoarthritis of the carpometacarpal joint of the thumb - personal experience with soft-tissue arthroplasty. *Acta Chirurgiae Orthopaedicae et Traumatologiae Cechoslovaca* 2001;**68**(1):50–4.

Smith 2002 ***{published data only}***
Smith A, Hartigan BJ, Stern PJ, Kiefhaber TR. Comparing results of surgical treatments for thumb carpometacarpal osteoarthritis. *Journal of Bone and Joint Surgery* 2002;**84A** (7):1275–6.

Sotereanos 1993 ***{published data only}***
Sotereanos DG, Taras J, Urbaniak JR. Niebauer trapeziometacarpal arthroplasty: a long-term follow-up. *Journal Hand Surgery* 1993;**18**(4):560–4.

Stein 2011 ***{published data only}***
Stein AJ, Schofield JL, Marsh M, Paulo J. Ligament reconstruction tendon interposition with mersilene augmentation. *Techniques in Hand & Upper Extremity Surgery* 2011;**15**(1):12–15.

Stussi 2000 ***{published data only}***
Stussi JD, Dap F, Merle M. Retrospective study of 69 primary trapeziometacarpal arthritis treated by total trapeziectomy combined in 34 cases with tendon interposition arthroplasty and in 35 cases with suspensionplasty. *Chirurgie de la Main* 2000;**19**(2):116–27.

Swanson 1983 ***{published data only}***
Swanson A, Swanson G. Osteoarthritis in the hand. *Journal Hand Surgery* 1983;**8A**(5):669–75.

Søndergaard 1991 ***{published data only}***
Søndergaard L, Konradsen L, Rechnagel K. Long-term follow-up of the cemented Caffinière prosthesis for trapezio-metacarpal arthroplasty. *Journal Hand Surgery* 1991;**16B** (4):428–30.

Taghinia 2008 ***{published data only}***
Taghinia AH, Al-Sheikh AA, Upton J. Suture anchor suspension and fascia lata interposition arthroplasty for Basal joint arthritis of the thumb. *Plastic and Reconstructive Surgery* 2008;**122**(2):497–504.

Takwale 2002 ***{published data only}***
Takwale V, Stanley J. Post-traumatic instability of the CMC joint of the thumb - diagnosis and results of reconstruction of the beak ligament. *Journal of Hand Surgery* 2002;**27B** (Supplement 1):27.

Thomsen 2000 ***{published data only}***
Thomsen NOB, Jensen CH, Nygaard H. Weilby-burton arthroplasty of the trapeziometacarpal joint of the thumb. *Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery* 2000;**34**(3):253–6.

Tomaino 1995 ***{published data only}***
Tomaino MM, Pellegrini VD Jr, Burton RI. Arthroplasty of the basal joint of the thumb. Long-term follow-up after

ligament reconstruction with tendon interposition. *Journal Bone and Joint Surgery* 1995;**77A**(3):346–55.

Tomaino 2000 ***{published data only}***
Tomaino MM. Treatment of Eaton stage I trapeziometacarpal disease with thumb metacarpal extension osteotomy. *Journal of Hand Surgery* 2000;**25**(6):1100–6.

Ulrich-Vinther 2008 ***{published data only}***
Ulrich-Vinther MH, Puggaard H, Lange B. Prospective 1-year follow up study comparing joint prosthesis with tendon interposition arthroplasty in treatment of trapeziometacarpal osteoarthritis. *Journal of Hand Surgery* 2008;**33**(8):1369–77.

van Cappelle 1999 ***{published data only}***
van Cappelle HGJ, Elzenga P, van Horn JR. Long-term results and loosening analysis of de la Caffiniere replacements of the trapeziometacarpal joint. *Journal of Hand Surgery* 1999;**24A**(3):476–82.

van Cappelle 2001 ***{published data only}***
van Cappelle HGJ, Deutman R, van Horn JR. Use of the Swanson silicone trapezium implant for treatment of primary osteoarthritis: long-term results. *Journal of Bone and Joint Surgery* 2001;**83A**(7):999–1004.

Vandenbroucke 1997 ***{published data only}***
Vandenbroucke J, De Schrijver F, De Smet L, Fabry G. Simple trapeziectomy for treatment of trapeziometacarpal osteoarthritis of the thumb. *Clinical Rheumatology* 1997;**16**(3):239–42.

Van Giffen 2002 ***{published data only}***
Van Giffen N, Van Ransbeeck H, De Smet L. Stabilization of the pre-arthritic trapeziometacarpal joint using ligament reconstruction. *Chirurgie de la Main* 2002;**21**(5):277–81.

Vermeulen 2011 ***{published data only}***
Vermeulen GM, Slijper H, Feitz R, Hovius SE, Moojen TM, Selles RW. Surgical management of primary thumb carpometacarpal osteoarthritis: A systematic review. *Journal of Hand Surgery* 2002;**36A**(1):157–69.

Voulliaume 2003 ***{published data only}***
Voulliaume D, Forli A, Guinard D, Corcella D, Moutet F. Anchovy dacron arthroplasty in the treatment of basal osteoarthritis of the thumb: long term results. *Chirurgie de la Main* 2003;**22**(4):197–202.

Wachtl 1997 ***{published data only}***
Wachtl SW, Guggenheim PR, Sennwald GR. Radiological evolution of cemented and non-cemented trapeziometacarpal prostheses. *Journal of Hand Surgery* 1997;**22B**(Supplement 1):9.

Wachtl 1998 ***{published data only}***
Wachtl SW, Guggenheim PR, Sennwald GR. Cemented and non-cemented replacements of the trapeziometacarpal joint. *Journal of Bone and Joint Surgery* 1998;**80B**(1):121–5.

Wajon 2005 ***{published data only}***
Wajon A, Ada L, Edmunds I. Surgery for thumb (trapeziometacarpal joint) osteoarthritis. *Cochrane Database of Systematic Reviews* 2005, Issue 4. [DOI: 10.1002/14651858.CD004631.pub2]

Yang 1998 ***{published data only}***
Yang SS, Weiland AJ. First metacarpal subsidence during pinch after ligament reconstruction and tendon interposition basal joint arthroplasty of the thumb. *Journal of Hand Surgery* 1998;**23A**(5):879–83.

Yao 2010 ***{published data only}***
Yao J, Zlotolow DA, Murdock R, Christian M. Suture button compared with K-wire fixation for maintenance of posttrapeziectomy space height in a cadaver model of lateral pinch. *Journal of Hand Surgery* 2010;**35A**(12):2061–5.

Yao 2012 ***{published data only}***
Yao J. Suture-button suspensionplasty for the treatment of thumb carpometacarpal joint arthritis. *Hand Clinics* 2012;**28**(4):579–85.

Young 1998 ***{published data only}***
Young BT, Rayan GM. Arthroplasty for trapeziometacarpal arthrosis. *Journal of the Oklahoma State Medical Association* 1998;**91**(2):53–9.

Young 2004 ***{published data only}***
Young SD, Mikola EA. Thumb carpometacarpal arthrosis. *Journal of the American Society for Surgery of the Hand* 2004;**4**(2):73–93.

Zancolli 2001 ***{published data only}***
Zancolli EA. The trapeziometacarpal joint: tenotomy of the accessory abductor pollicis longus tendons in early osteoarthritis. *Hand Clinics* 2001;**17**(1):13–43.

Zollinger 2008 ***{published data only}***
Zollinger PE, Ellis ML, Unal H, Tuinebreijer WE. Clinical outcome of cementless semi-constrained trapeziometacarpal arthroplasty, and possible effect of vitamin C on the occurrence of complex regional pain syndrome. *Acta Orthopaedica Belgica* 2008;**74**(3):317–22.

References to studies awaiting assessment

Hansen 2013 ***{published data only}***
Hansen T, Stilling M. Equally good fixation of cemented and uncemented cups in total trapeziometacarpal joint prostheses: A randomized clinical RSA study with 2-year follow-up. *Acta Orthopaedica* 2013;**84**(1):98–105.

Additional references

Armstrong 1994
Armstong AL, Hunter JB, Davis TRC. The prevalence of degenerative arthritis of the base of the thumb in post-menopausal women. *Journal of Hand Surgery* 1994;**19B**(3):340–1.

Bellamy 1997
Bellamy N. How do we measure osteoarthritis? Clinical outcome measures. *Annals of the Rheumatic Diseases* 1997;**56**(7):447–8.

Bellamy 1997a
Bellamy N, Kirwan J, Boers M, Brooks P, Strand V, Tugwell P, et al. Recommendations for a core set of outcome measures for future Phase 111 clinical trials in knee, hip and hand osteoarthritis. Consensus development at

OMERACT III. *Journal of Rheumatology* 1997;**24**(4): 799–802.

Bellamy 1999
Bellamy N. Clinimetric concepts in outcome assessment: the OMERACT filter. *Journal of Rheumatology* 1999;**26**(4): 948–50.

Bellemère 2011b
Bellemère P, Ardouin L. Pi2 spacer pyrocarbon arthroplasty technique for thumb basal joint osteoarthritis. *Techniques in Hand & Upper Extremity Surgery* 2011;**15**(4):247–52.

Brooks 2001
Brooks P, Hochberg M, ILAR, OMERACT. Outcome measures and classification criteria for the rheumatic diseases. A compilation of data from OMERACT (Outcome Measures for Arthritis Clinical Trials), ILAR (International League of Associations for Rheumatology), regional leagues and other groups. *Rheumatology* 2001;**40** (8):896–906.

Casanova 1992
Casanova JS (editor). *Clinical Assessment Recommendations*. 2nd Edition. Chicago, IL: American Society of Hand Therapists, 1992.

Davis 2004
Davis TRC, Brady O, Dias JJ. Excision of the trapezium for osteoarthritis of the trapeziometacarpal joint: a study of the benefit of ligament reconstruction or tendon interposition. *Journal of Hand Surgery* 2004;**29A**(6):1069–77.

Domholdt 2000
Domholdt E. *Physical therapy research: principles and applications*. 2nd Edition. Philadelphia: Saunders, 2000.

Eaton 1973
Eaton RG, Littler JW. Ligament reconstruction for the painful thumb carpometacarpal joint. *Journal of Bone & Joint Surgery* 1973;**55**(8):1655–66.

Eaton 1987
Eaton RG, Glickel SZ. Trapeziometacarpal osteoarthritis. Staging as a rationale for treatment. *Hand Clinics* 1987;**10A** (5):645–53.

Egger 1997
Egger M, Smith GD, Phillips AN. Meta-analysis: principles and procedures. *BMJ* 1997;**315**(7121):1533–7.

Froimson 1970
Froimson AI. Tendon arthroplasty of the trapeziometacarpal joint. *Clinical Orthopaedics and Related Research* 1970;**70**: 191–9.

Gervis 1949
Gervis WH. Excision of the trapezium for osteoarthritis of the trapezio-metacarpal joint. *Journal of Bone & Joint Surgery* 1949;**31**(4):357–9.

Glickel 2001
Glickel SZ. Clinical assessment of the thumb trapeziometacarpal joint. *Hand Clinics* 2001;**17**(2):185–95.

GRADEpro 2014 [Computer program]
McMaster University. GRADEpro. McMaster University, 2014.

Gummesson 2004
Gummesson C, Atroshi I, Ekdahl C. The quality of reporting and outcome measures in randomised clinical trials related to upper-extremity disorders. *Journal of Hand Surgery* 2004;**29A**(4):727–34.

Haugen 2011
Haugen IK, Bøyesen P. Imaging modalities in hand osteoarthritis--and perspectives of conventional radiography, magnetic resonance imaging, and ultrasonography. *Arthritis Research & Therapy* 2011;**13**(6):248.

Hunsaker 2002
Hunsaker FG, Cioffi DA, Amadio PC, Wright JG, Caughlin B. The American Academy of Orthopaedic Surgeons outcomes instruments: normative vValues from the general population. *Journal Bone and Joint Surgery* 2002;**84A**(2): 208–15.

Jebsen 1969
Jebsen RH, Taylor N, Trieschmann RB, Trotter MJ, Howard LA. An objective and standardized test of hand function. *Archives of Physical Medicine and Rehabilitation* 1969;**50**(6):311–9.

MacDermid 2007
MacDermid JC. The Patient-Rated Wrist Evaluation (PRWE)© User Manual. http://www.srs-mcmaster.ca/Portals/20/pdf/research˙resources/ PRWE˙PRWHEUserManual˙Dec2007.pdf (accessed dd Month 2007).

Martou 2004
Martou G, Veltri K, Thoma A. Surgical treatment of osteoarthritis of the carpometacarpal joint of the thumb: a systematic review. *Plastic and Reconstructive Surgery* 2004; **114**(2):421–32.

Moher 2003
Moher D, Schulz KF, Altman DG, CONSORT Group. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomised trials. *Lancet* 2001;**357**(9263):1191–4.

Pellegrini 1993
Pellegrini VD Jr, Olcott CW, Hollenberg G. Contact patterns in the trapeziometacarpal joint: the role of the palmar beak ligament. *Journal Hand Surgery* 1993;**18A**(2): 238–44.

RevMan 2014 [Computer program]
The Nordic Cochrane Centre. The Cochrane Collaboration. Review Manager (RevMan). Version 5.3. Copenhagen: The Nordic Cochrane Centre. The Cochrane Collaboration, 2014.

Sauerland 2004
Sauerland S, Davis TRC. The Consolidated Standards of Reporting Trials (CONSORT): better presentation of surgical trials in the Journal of Hand Surgery. *Journal of Hand Surgery* 2004;**29B**(6):621–4.

Schmidt 2000
Schmidt CC, McCarthy DM, Arnoczky SP, Herndon JH. Basal joint arthroplasty using an allograft tendon

interposition versus no interposition: a radiographic, vascular, and histologic study. *Journal of Hand Surgery* 2000;**25**(3):447–57.

Schulz 1995
Schulz K. Subverting randomization in controlled trials. *JAMA* 1995;**274**(18):1456–8.

Sihvonen 2013
Sihvonen R, Paavola M, Malmivaara A, Itälä A, Joukainen A, Nurmi H, et al. Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. *New England Journal of Medicine* 2013;**369**(26):2515–24.

Sodha 2005
Sodha S, Ring D, Zurakowski D, Jupiter JB. Prevalence of osteoarthrosis of the trapeziometacarpal joint. *Journal of Bone and Joint Surgery* 2005;**87A**(12):2614–8.

Sollerman 1995
Sollerman C, Ejeskär A. Sollerman hand function test. A standardised method and its use in tetraplegic patients. *Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery* 1995;**29**(2):167–76.

Solway 2002
Solway S, Beaton D, McConnel S, Bombardier C. *The DASH Outcome Measure User's Manual*. Toronto: Institute for Work & Health, 2002.

Swanson 1972
Swanson AB. Disabling arthritis at the base of the thumb: treatment by resection of the trapezium and flexible (silicone) implant arthroplasty. *Journal of Bone and Joint Surgery* 1972;**54A**(3):456–71.

Swigart 1999
Swigart CR, Eaton RG, Gllickel SZ, Johnson C. Splinting in the treatment of arthritis of the first carpometacarpal joint. *Journal of Hand Surgery* 1999;**24A**(1):86–91.

Taleb 2014
Taleb C, Berner S, Mantovani Ruggiero G. First metacarpal resurfacing with polyvinyl alcohol implant in rhizarthrosis: preliminary study. *Chirurgie de la Main* 2014;**33**(3): 189–95.

Trumble 2000
Trumble TE, Rafijah G, Gilbert M, Allan CH, North E, McCallister WV. Thumb trapeziometacarpal joint arthritis: partial trapeziectomy with ligament reconstruction and interposition costochondral allograft. *Journal of Hand Surgery* 2000;**25A**(1):61–76.

Uchiyama 1999
Uchiyama S, Cooney WP, Niebur G, An K-N, Linscheid RL. Biomechanical analysis of the trapeziometacarpal joint after surface replacement arthroplasty. *Journal of Hand Surgery* 1999;**24**(3):483–90.

Visual Rx
Cates C. Visual Rx. http://www.nntonline.net/visualrx/ (accessed dd Month 2014).

Wajon 2000
Wajon A. Clinical splinting successes: the thumb "strap splint" for dynamic instability of the trapeziometacarpal joint. *Journal of Hand Therapy* 2000;**13**(3):236–7.

Wajon 2005a
Wajon A, Ada L. No difference between two splint and exercise regimens for people with osteoarthritis of the thumb: a randomised controlled trial. *Australian Journal of Physiotherapy* 2005;**51**(4):245–9.

References to other published versions of this review

Wajon 2005b
Wajon A, Ada L, Edmunds I. Surgery for thumb (trapeziometacarpal joint) osteoarthritis. *Cochrane Database of Systematic Reviews* 2005, Issue 4. [DOI: 10.1002/14651858.CD004631.pub2]

Wajon 2009
Wajon A, Carr E, Edmunds I, Ada L. Surgery for thumb (trapeziometacarpal joint) osteoarthritis. *Cochrane Database of Systematic Reviews* 2009, Issue 4. [DOI: 10.1002/14651858.CD004631.pub3]

* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Belcher 2000

Methods	RCT Experimental group (Exp): Trapeziectomy with LRTI (APL) Control group (C): Trapeziectomy
Participants	Age (mean): Exp/C = 58/63 Gender (female/male): Exp/C = 19:4/18:1 Stage of OA (mean): Exp/C = 3.0/3.5
Interventions	Surgery Exp/C: Exp: Trapeziectomy with LRTI (using dorsal slip of APL). Postoperative backslab, then customised splint fitted at 2 weeks, including wrist in extension, thumb trapeziometacarpal joint in abduction and metacarpophalangeal joint in extension. Gentle mobilisation at 4 weeks, splint discharged at 6 weeks C: Trapeziectomy. Postoperative backslab, then customised splint fitted at 2 weeks, including wrist in extension, thumb trapeziometacarpal joint in abduction and metacarpophalangeal joint in extension. Gentle mobilisation at 4 weeks, splint discharged at 6 weeks
Outcomes	Pain: A 10 cm VAS was used to assess thumb pain, with '0' indicating no pain and '10' terrible pain. Physical function: A 100 mm VAS was used to score 'how well the hands work generally', with '0' indicating full function and '10' no use. Patient global assessment: Not reported. Range of motion: Trapeziometacarpal extension (radial abduction) and abduction (palmar abduction) were measured as the distance between the thumb interphalangeal joint crease and the palmar crease. Strength: Grip strength was measured with the Jamar dynamometer, and pulp (2 point) and key (lateral) pinch were measured with a pinch-meter and measured in kg. Trapeziometacarpal joint imaging: Measurement of the distance between the base of the thumb metacarpal and the distal end of the scaphoid were reported as the scaphometacarpal distance in mm. The distance between the base of the thumb metacarpal and the radial border of the trapezoid were reported as trapeziometacarpal distance in mm. Adverse events: Complications of recurrent pain, instability, neuroma, sensory loss and tendon (FCR) rupture were reported
Notes	Follow-up at 14 months (7 to 29). We tried to contact a trial author. No further information was provided Two review authors (AW and EC) calculated SD from standard error (SE) values provided

Risk of bias		*Risk of bias*
Bias	**Authors' judgement**	**Support for judgement**

Belcher 2000 (*Continued*)

Random sequence generation (selection bias)	Low risk	Quote: "patients were randomised by spinning a coin".
Allocation concealment (selection bias)	Low risk	Comment: Randomisation performed after trapezium was completely excised
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Comment: Unclear if participants or assessors were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Comment: Unclear if participants were informed of surgery prior to final review. We cannot exclude observer bias in recording outcomes (e.g. rounding up or down) as we do not know if they were blinded until final review
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Quote: "one patient was lost to follow up [at 14 months]". Comment: Unclear which operation the patient lost to follow-up received
Selective reporting (reporting bias)	Unclear risk	Comment: No protocol identified.

De Smet 2004

Methods	RCT Exp: Trapeziectomy with LRTI (FCR) C: Trapeziectomy
Participants	Age (mean): Exp/C = 61.5/58 Gender (female/male): Exp/C = 34:0/22:0 Stage of OA (mean): Exp/C = not reported
Interventions	Surgery Exp/C: Exp: Trapeziectomy with LRTI (using entire FCR). Mobilisation started within a week with no immobilisation C: Trapeziectomy. Mobilisation started immediately.
Outcomes	Pain: Pain was scored on a 10 cm visual analogue scale (VAS). Physical function: The DASH (Disabilities Arm, Shoulder, Hand) was completed, with 0 = no disability and 100 = maximal disability Patient global assessment: Not reported. Range of motion: The 'web angle' is reported for both groups and increased from 63.6

De Smet 2004 (*Continued*)

	degrees to 84.8 degrees postoperatively. No between group comparisons were made Strength: Key pinch and grip strength were reported as percentages of postoperative/preoperative scores. No raw scores were provided Trapeziometacarpal joint imaging: The trapezial space was reported as a percentage of postoperative/preoperative scores. No raw scores were provided Adverse events: Complications were not reported. One subject was considered a failure and not included in analysis at follow-up
Notes	Follow-up of trapeziectomy group at mean of 34 months (9 to 84); follow-up of trapeziectomy with LRTI group at mean of 26 months (9 to 54) We tried to contact a trial author. No further information was provided

Risk of bias ***Risk of bias***

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Quote: "the choice of procedure was at random".
Allocation concealment (selection bias)	Unclear risk	-
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Comment: Unclear if participants or assessors were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Comment: Unclear if participants were informed of surgery prior to final review. We cannot exclude the possibility of observer bias in recording outcomes (e.g. rounding up or down) as it is unknown if they were blinded until final review
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	-
Selective reporting (reporting bias)	Unclear risk	Comment: We did not identify a protocol.

Field 2007

Methods	RCT Exp: Trapeziectomy with LRTI (half FCR) C: Trapeziectomy

Field 2007 (*Continued*)

Participants	Age (mean): 55 Gender (female/male): Exp/C = 28:5/28:4 Stage of OA (number): Exp/C = 15 gr III, 18 gr IV/14 gr III, 18 gr IV
Interventions	Surgery Exp/C: Exp: Trapeziectomy with LRTI (using half of FCR). All patients immobilised in Bennett's type cast for 4 weeks, then mobilised for further 4 to 6 weeks C: Trapeziectomy.
Outcomes	Pain: Pain was measured on a VAS. Physical function: Not reported. Patient global assessment: Not reported. Range of motion: Palmar and radial abduction was measured in degrees and first web space span was measured in cm Strength: Grip and key and tip pinch strength were measured in kg Trapeziometacarpal joint imaging: Mean scapho-metacarpal distance (mm) was measured pre-operatively and at 12 months postoperatively Adverse events: complications including superficial wound infections, radial nerve irritation, adherent scars and CRPS were reported
Notes	Follow-up at 3, 6 and 12 months. We contacted a trial author who provided mean and SD values for range of motion, pain and strength and information on blinding

Risk of bias ***Risk of bias***

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Comment: Computer randomised numbers.
Allocation concealment (selection bias)	Unclear risk	Comment: Sealed envelopes, unclear if they were opaque, sequentially numbered or kept by someone other than the surgeon until needed or when allocation occurred
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	Comment: Assessors appropriately blinded (personal communication)

Field 2007 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: All patients attended for 12-month follow-up.
Selective reporting (reporting bias)	Unclear risk	Comment: We identified a protocol (http://www.controlled-trials.com/isrctn/pf/05154295) which provided limited information on outcomes

Gangopadhyay 2012

Methods	RCT Group A: Trapeziectomy alone Group B: Trapeziectomy with Interpositional Arthroplast (Palmaris Longus) Group C: Trapeziectomy with LRTI (FCR)
Participants	Age (median): A/B/C = 57/57/57 Gender (female:male): A/B/C = 53:0/46:0/54:0 Stage of OA (mean): A/B/C = 3.5/3.6/3.7
Interventions	Surgery: Group A: Trapeziectomy using a dorsal approach. Percuatenous K-wire was inserted through base of thumb metacarpal and passed longitudinally across the trapezial void into the distal scaphoid. THe K-wire was removed at 4 weeks. A Plaster of Paris splint maintained the thumb in abduction with wrist in neutral for 6 weeks. At 6 weeks the patient started hand therapy to mobilise and strengthen the thumb Group B: Trapeziectomy with interposition of palmaris longus tendon, sutured into a ball before placement into trapezial void. Postoperative thumb and wrist supported in Plaster of Paris splint with wrist in neutral and thumb in abduction. Kirschner wire through base of thumb metacarpal into distal pole of scaphoid for 4 weeks. Exercises to mobilise and strengthen thumb shown at 6 weeks when splint discarded Group C: Trapeziectomy with LRTI (using FCR). Same technique as Burton 1986. Percuatenous K-wire was inserted through base of thumb metacarpal and passed longitudinally across the trapezial void into the distal scaphoid. THe K-wire was removed at 4 weeks. A Plaster of Paris splint maintained the thumb in abduction with wrist in neutral for 6 weeks. At 6 weeks the patient started hand therapy to mobilise and strengthen the thumb
Outcomes	Pain: The number of subjects who reported 'no pain or restrictions; discomfort with use, but no restrictions; pain with use, some restrictions; rest pain, no restrictions; rest pain, some restrictions; rest pain, severe restrictions; night pain' were recorded for each group Physical function: Not reported. Patient global assessment: Not reported. Range of motion: Thumb opposition and thumb metacarpophalangeal hyperextension Strength: Grip strength was measured with the Jamar dynamometer, and tip and key (lateral) pinch were measured with a Jamar pinch-meter and measured in kg Trapeziometacarpal joint imaging: No postoperative imaging was performed Adverse events at 1 year and 5 years or more: nerve dysfunction (superficial radial nerve or palmar cutaneous branch of median), FCR/pollicis longus pulling sensation, tender

Gangopadhyay 2012 (*Continued*)

	scar, CRPS
Notes	We contacted one of the trial authors for further information who confirmed that same patient cohort as Davis 1997 and Davis 2004 published studies. One review author (TV) converted median and IQR to mean and SD values

Risk of bias ***Risk of bias***

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "Randomisation occurred at induction of anaesthesia...stratified so 3 of each operation was conducted for each set of 9 consecutive surgeries."
Allocation concealment (selection bias)	Low risk	Quote: "randomisation was achieved by opening the next sequentially sealed opaque envelope that contained instructions as to which operation should be performed" Comment: Patient and surgeon adequately blinded from which procedure was to be performed until time of incision
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Comment: Unclear if participants or assessors were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	Comment: Two independent observers who were not involved in the surgical procedure carried out all assessments at final follow-up
Incomplete outcome data (attrition bias) All outcomes	Low risk	Quote: "of the 174 operated thumbs...153 were assessed at a median of 6 years" Comment: No indication from which patient group the patients were not reviewed belonged, however information provided about why the patients could not be reviewed (moved/died/refused to participate) . High rate of follow-up
Selective reporting (reporting bias)	Unclear risk	Comment: We identified a protocol (http://www.controlled-trials.com/isrctn/pf/22417311) but it did not provide

Gangopadhyay 2012 (*Continued*)

		information on assessed outcomes

Gerwin 1997

Methods	RCT Exp: Trapeziectomy with LRTI (FCR) C: Trapeziectomy with ligament reconstruction with Mitek suture anchor
Participants	Age (mean): Exp/C = 61/62 Gender: Exp/C = 9/11 Stage of OA (mean): Exp/C = not stated Number of subjects: Exp/C = 9/11
Interventions	Surgery Exp/C: Exp: Trapeziectomy with LRTI (FCR) C: Trapeziectomy with ligament reconstruction (no rolled tendon spacer used to place within the void of the resected trapezium). Post-operative management not stated
Outcomes	Pain: Not reported Physical function: Subjective overall satisfaction with the procedure was reported for the 2 groups Patient global assessment: Not reported Range of motion: Radial and palmar abduction were measured in degrees and the ability of the thumb to touch the volar aspect of the 5th MP joint was recorded at 23 months follow-up Strength: Grip strength was measured with the Jamar dynamometer, and 2 point and 3 point pinch strength were measured with a pinch-meter at 23 month follow-up and measured in kg Trapeziometacarpal joint imaging: The height of the reconstructed basal joint (scapho-metacarpal distance) was measured on lateral radiographs both at rest and during pinch Adverse events: Not reported
Notes	Average follow-up of 23 months We tried to contact one of the trial authors but no further information was provided

Risk of bias ***Risk of bias***

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Quote: "patients were randomised to one of two groups". Comment: Method of randomisation sequence generation was not stated
Allocation concealment (selection bias)	Unclear risk	-

Gerwin 1997 (*Continued*)

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Quote: "Patients returned for blind assessment". Comment: Unclear who was blinded or how they were blinded.
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Comment: Unclear if participants were informed of surgery prior to final review. Observer bias in recording outcomes cannot be excluded (e.g. rounding up or down) as it is unknown if they were blinded until final review
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Comment: No comment on if all enrolled participants were reviewed or if any were lost to follow-up
Selective reporting (reporting bias)	Unclear risk	We did not identify a protocol.

Hart 2006

Methods	RCT Exp: Trapeziectomy with LRTI (FCR) C: Arthrodesis
Participants	Age (mean): 59 (49 to 75) Gender (female/male): 24/13 Stage of OA: stage IV Number of subjects Exp/C: 20/20
Interventions	Surgery Exp/C: Exp: Trapeziectomy with LRTI (FCR) C: Arthrodesis using 2 crossed Kirschner wires. All patients were immobilised in thumb spica cast for 6 weeks
Outcomes	Outcomes were measured using the Buck-Gramcko score which included palmar and radial abduction, pain, strength, daily function, dexterity, cosmetic appearance, willingness to undergo the surgery again and overall satisfaction. Mean scores were provided but individual results for outcomes were not
Notes	Average follow-up of 6.8 years (2 to 10 years) We tried to correspond with the contact author. No further information was provided

Risk of bias	***Risk of bias***

Hart 2006 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "patients were selected at random into two groups as they came into the authors' institution". However method of randomisation sequence generation was not stated
Allocation concealment (selection bias)	Unclear risk	-
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Comment: Unclear if participants or assessors were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Comment: Reviewer was not was involved in the surgery but unclear if he was blinded to surgery performed
Incomplete outcome data (attrition bias) All outcomes	Low risk	Quote: "All patients were available for review at a mean of 6.8 years (2 to 10 years)"
Selective reporting (reporting bias)	Unclear risk	Comment: We did not identify a protocol.

Kriegs-Au 2004

Methods	RCT Exp: Trapeziectomy with LRTI (FCR) C: Trapeziectomy with ligament reconstruction alone
Participants	Age (mean): Exp/C = 58/59 Gender (female/male): Exp/C = 12:4/13:2 Stage of OA (number of subjects): Exp/C = Exp: 3 Stage II, 11 Stage III, 2 Stage IV / C: 2 Stage II, 11 Stage III, 2 Stage IV
Interventions	Surgery Exp/C: Exp: Trapeziectomy with LRTI (using FCR). Postoperative spica cast for 3 weeks, replaced with customised thumb spica splint until 6 weeks. Active and active-assisted ROM and thenar strengthening exercises begun at 6 weeks C: Trapeziectomy with ligament reconstruction (no tendon interposition). Postoperative spica cast for 3 weeks, replaced with customised thumb spica splint until 6 weeks. Active and active-assisted ROM and thenar strengthening exercises begun at 6 weeks

Kriegs-Au 2004 (*Continued*)

Outcomes	Pain: Number of subjects reporting pain at rest and during strain are reported preoperatively, with pain frequency (never, occasional, frequent, constant) reported postoperatively Physical function: The number of subjects reporting moderate difficulty with activities of daily living (writing, brushing teeth, threading needle, turning key, opening tight jar, using knife or scissors, buttoning clothes, zipping clothes, picking up small objects, and playing cards) are reported Patient global assessment: Overall assessment of subjective outcomes were assessed with the grade of the total Buck-Gramcko score, with scores of 49 to 56/56 achieving an 'excellent' result, 40 to 48/56 'good', 28 to 39/56 'fair' and < 28/56 'poor' Range of motion: Mean palmar and radial abduction were measured in degrees with a goniometer, and opposition (the ability to touch the palmar crease of the little finger with thumb tip), were measured both preoperatively and at final follow-up Strength: Grip strength was measured with the Martin vigorimeter, and tip (2 point) pinch was measured with a pinch-meter, and measured in bar (Pa). Trapeziometacarpal joint imaging: Standard PA and oblique radiographs were performed preoperatively and at follow-up. The index of the height of the arthroplasty space was calculated by dividing the scapho-metacarpal distance by the length of the 1st metacarpal. The index was calculated both at rest and under stress postoperatively Adverse events: Complications of nerve irritation and Reflex Sympathetic Dystrophy were reported
Notes	Average 48.2 months follow-up (15 to 120) Attempt was made to contact author. No further information was provided Two of our authors (AW and EC) calculated SDs using means, sample size for each group and exact P value for (2-tailed) difference between groups

Risk of bias ***Risk of bias***

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "computer-generated randomization list"
Allocation concealment (selection bias)	Unclear risk	Unclear when allocation occurred.
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Comment: Unclear if participants or assessors were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Quote: "independent observers" Comment: unclear if observers were blinded to the procedure performed though the observers had not been involved

Kriegs-Au 2004 (*Continued*)

		in the surgery or care of the patient
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: Of 43 patients enrolled in the study, 12 were not included in final assessment (break down of reasons and which group participants were supplied). Of the bilateral hands, only the thumb operated on first was used for statistical analysis
Selective reporting (reporting bias)	Unclear risk	Comment: We did not identify a protocol.

Nilsson 2005

Methods	Controlled, prospective pilot study Exp A: Artelon TMC Spacer anchored with osteosutures Exp B: Artelon TMC Spacer anchored with titanium screws C: Trapeziectomy with tendon interposition (APL)
Participants	Age (mean): Exp/C = 56/62 Gender (female/male): Exp/C = 9/1:5/0 Stage of OA (number of subjects): Exp/C = not reported, although all patients had isolated trapeziometacarpal osteoarthritis
Interventions	Surgery Exp/C: Exp A: Artelon TMC Spacer anchored to bone with osteosutures Exp B: Artelon TMC Spacer anchored with titanium screws C: Trapeziectomy with APL arthroplasty. Postoperative = thumb immobilised in spica cast for 5 weeks
Outcomes	Pain: VAS was used, with 0 representing no pain, 10 maximum pain. Note, measurements were recorded at maximum loading during key pinch Physical function: Sollerman Hand Function test was performed Patient global assessment: Likert scale of patients' subjective assessment of the treatment result at 3 year follow-up Range of motion: radial and palmar abduction was measured in degrees with a goniometer Strength: grip strength was measured with a Jamar dynamometer, key and tripod pinch measured with a pinch gauge (North Coast Medical, Inc) Trapeziometacarpal joint imaging was performed to identify dislocation or adverse host tissue response Adverse events of local swelling and tenderness were reported at 2 weeks after surgery
Notes	We attempted to contact one of the trial authors. No further information was provided One review author (EC) converted median into mean and SD values Acknowledgements: The Artelon manufacturer funded the trial

Risk of bias ***Risk of bias***

Bias	**Authors' judgement**	**Support for judgement**

Nilsson 2005 (*Continued*)

Random sequence generation (selection bias)	High risk	Comment: Controlled, prospective pilot study (no randomisation)
Allocation concealment (selection bias)	High risk	-
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	Quote: "Indepdent observer who did not know which treatment group the patient had received examined all patients at the 3-year follow-up"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: One (APL) patient was followed up for 2 years, but not available for 3-year review. Reason provided
Selective reporting (reporting bias)	High risk	Comment: No protocol identified. Sollerman hand score listed in methods but no reported in results

Nilsson 2010

Methods	RCT Exp: Artelon TMC Spacer C: Trapeziectomy with tendon interposition (APL, ECRL or FCR)
Participants	Age (mean): Exp/C = 59/61 Gender (female/male): Exp/C = 61/9:33/4 Stage of OA (number of subjects): Exp/C = Eaton stage 1-3 verified radiographically. Preoperative Eaton stage 4 were excluded
Interventions	Surgery Exp/C: Exp A: Artelon TMC Spacer. Dosral approach used. Postopeartively 5 to 6 weeks of plaster fixation followed by mobilisation program C: Trapeziectomy with interposition (22 cases with APL; 6 cases with ECRL; 9 cases with 9 cases). Same postoperative care as experimental group
Outcomes	Pain: VAS was used, with 0 representing no pain, 10 maximum pain. Note: measurements were recorded at maximum loading during key pinch Physical Function: DASH Score Patient global assessment: Patient satisfaction was recorded from 1 (not at all satisfied) to 5 (very satisfied/very good)

	Range of motion: Radial and palmar abduction was measured in degrees with a goniometer Strength: grip strength was measured with a Jamar dynamometer, key and tripod pinch measured with a pinch gauge (North Coast Medical, Inc) Imaging: Joint space was measured (preoperatively and at 1 year) using plain x-rays. Degree of OA was evaluated preoperatively Complications: Joint swelling and pain.
Notes	Acknowledgements: Artelon manufacturer funded the trial Results reporting: Some results were reported using an ITT analysis while some were reported using a per-protocol analysis. Data used for meta-analysis was ITT data unless otherwise stated

Risk of bias ***Risk of bias***

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Quotes: "according to a randomization list". Comment: unclear how the list was generated but appears to be randomised appropriately but using non-patient related generation (i.e. not year of birth or date of procedure). Allocation was suggested to have prior to procedural anaesthesia: "After giving informed consent, the patients were randomized"
Allocation concealment (selection bias)	Unclear risk	Quote: "by using closed envelopes". Comment: unclear if the envelopes were sequential or chosen at random, and who stored the envelopes prior to them being used
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	Quote: "the observers carrying out the follow-up investigations were not informed about which surgical procedure the individual patient had undergone"
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: Reasons and allocation of participant attrition clearly identified but

Nilsson 2010 (*Continued*)

		many more participants excluded at follow-up from experimental group Exp: 9 participants were excluded after surgery (6 reoperation, 1 serious illness, 2 did not attend follow-up) C: 2 participants did not attend follow-up.
Selective reporting (reporting bias)	Unclear risk	Comment: We did not identify a protocol.

Salem 2012

Methods	RCT Exp: Trapeziectomy with LRTI C: Trapeziectomy alone.
Participants	Age (mean): Exp/C = 61/60 Gender (female/male): Exp/C = 46/9:51/8 Stage of OA (number of subjects): Exp/C = not reported, however 10 patients in the experiment and 9 patients in the control group had scaphotrapeziotrapezoid joint osteoarthritis
Interventions	Exp: Trapeziectomy with LRTI (FCR). K-wire to suspend thumb metacarpal for 4 weeks. Postoperatively a Plaster of Paris thumb spica splint was worn and then removed at 4 weeks. A thermoplastic splint was then worn for another 2 weeks with the thumb adducted C: Trapeziectomy. Postoperative immobilisation with bulky crepe bandage leaving the fingers free and removed after 3 to 4 weeks and replaced with a night splint
Outcomes	Pain: The number of subjects who reported 'no pain or restrictions; discomfort with use, but no restrictions; pain with use, some restrictions; rest pain, no restrictions; rest pain, some restrictions; rest pain, severe restrictions; night pain' were recorded for each group Physical function: DASH Score Patient global assessment: Patient Evaluation Measure Range of motion: Radial and palmar abduction; opposition; thumb metacarpophalangeal extension; Strength: Grip, key (lateral) pinch and tip pinch strength was measured with the same calibrated dynamometer or pinch meter and was measured in kg Adverse events at 3 months, 1 year and 6 years: Numbness/tingling/tenderness in the innervation area of radial nerve or the palmar cutaneous branch of the median nerve, FCR pulling, De Quervain's disease, scar tenderness and chronic regional pain syndrome
Notes	We contacted the senior author (Davis) who confirmed this study used the same cohort of patients as the Davis 2009 study. One review author (TV) converted 95% CIs into SDs

Risk of bias ***Risk of bias***

Bias	**Authors' judgement**	**Support for judgement**

Salem 2012 (*Continued*)

Random sequence generation (selection bias)	Unclear risk	Quote: "three of each procedure was performed for every 6 patients" (Davis 2009) and "patients who had already been recruited into this study for surgery for the contralateral thumb had the alternative procedure performed on the contralateral side" Comment: Unclear how the sequence was generated. Opposite procedure was performed on the contralateral hand of some patients
Allocation concealment (selection bias)	Unclear risk	Quote: "A stratified sealed-envelope technique was used for patients who contralateral thumb had not already been entered into this study"
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Comment: Unclear if participants or assessors were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	Comment: A trainee surgeon followed up the patients at the 6-year review mark reducing the risk of bias
Incomplete outcome data (attrition bias) All outcomes	Low risk	Twelve patients (15 operations) were not reviewed at 6 years from a total of 111 patients (131 operations) Comment: Unclear how many patients from each group were not-followed up and for what reason (e.g. 3 patients died in both the T and T+LRTI group) however there were low attrition rates
Selective reporting (reporting bias)	Unclear risk	Comment: We did not identify a protocol.

Tagil 2002

Methods	RCT Exp: Trapeziectomy with tendon interposition (APL) C: Trapeziectomy with Swanson silicone trapezium implant

Tagil 2002 (*Continued*)

Participants	Age (mean): Exp/C = 62/62 Gender (female/male): Exp/C = 12:1/12:1 Stage of OA (mean): Exp/C = not stated
Interventions	Surgery Exp/C: Exp: Trapeziectomy with tendon interposition (APL). Postoperative plaster cast immobilisation of the thumb for 5 weeks C: Trapeziectomy with Swanson silicone trapezium implant. Postoperative plaster cast immobilisation of the thumb for 5 weeks
Outcomes	Pain: A 100 mm VAS was used to assess average daytime thumb pain, and the number of subjects with sleep disturbing pain and continuous pain were reported Physical function: The number of subjects reporting pain with heavy work and light work were reported Patient global assessment: Not reported Range of motion: Radial abduction and palmar abduction were measured with a goniometer Strength: Grip strength, thumb tip (2 point) and key (lateral) pinch strength were measured with a Martin Vigorometer and reported in kp/cm^2 Trapeziometacarpal joint imaging: Measurement of the distance between the base of the thumb metacarpal and the distal end of the scaphoid were reported as trapezial height in mm. The measurement was repeated during pinch against the index finger to detect a further decrease in the functional trapezial space Adverse events: Complications of cyst formation and dislocation of the prosthesis in the Swanson group were reported
Notes	Mean follow-up of Swanson group 45 months (22 to 66); trapeziectomy with IA (APL) group 41 months (23 to 66) We contacted one of the trial authors who provided mean and SDs for range of motion, pain and lateral pinch strength

Risk of bias ***Risk of bias***

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Quote: "patients were randomised into two groups".
Allocation concealment (selection bias)	Unclear risk	-
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Comment: Unclear if participants or assessors were informed of surgery performed prior to final review
Blinding of outcome assessment (detection bias) Subjective outcomes (patient reported)	Unclear risk	Comment: Unclear if participants were informed of surgery performed prior to final review

Tagil 2002 (*Continued*)

Blinding of outcome assessment (detection bias) Objective outcomes	High risk	Comment: Surgeon who performed the operation conducted the review
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: Two patients were lost to follow-up. Reasons and allocations were identified
Selective reporting (reporting bias)	Unclear risk	Comment: We did not identify a protocol.

C = control; Exp = experimental; OA = osteoarthritis; APL = abductor pollicis longus; FCR = flexor carpi radialis; ECRL: extensor carpi radialis longus; DASH = Disability of the Arm, Shoulder and Hand.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Abzug 2011	Descriptive study
Adams 1990	Observational study
Alnot 1998	Descriptive study
Amadio 1990	Descriptive study
Angly 2006	Observational study
Ardouin 2011	Observational study
Atroshi 1997	Observational study
Atroshi 1998	Descriptive study
Bamberger 1992	Observational study
Barron 1998	Observational study
Battiston 1997	Descriptive study
Belcher 2001	Trial terminated early due to adverse effects and only 6 month outcome data
Beldame 2010	Observational study

(*Continued*)

Bellemère 2011a	Observational study
Berggren 2001	No intervention of interest
Bezwada 2002	Observational study
Brand 2007	Observational study
Braun 1982	No intervention of interest
Brunton 2011	Descriptive study
Budoff 2002	Observational study
Burton 1973	Review
Burton 1986	Observational study
Burton 1987	Review
Camus 2000	Descriptive study
Caputo 1993	Observational study
Carneiro 2007	No comparison of interest
Carroll 1987	Observational study
Chakrabarti 1997	Observational study
Chamay 1994	Observational study
Clough 1990	Observational study
Conolly 1989	Observational study
Conolly 1993	Descriptive study
Cox 2010	Review
Creamer 1998	Review
Cristiani 1997	Observational study
Dacatra 2001	No intervention of interest
Damen 1997	Observational study

(*Continued*)

Damen 2000	Observational study
Damen 2001	Observational study
Day 2004	No intervention of interest
Dell 1978	Observational study
Dhar 1994	Observational study
Dodaro 1999	Observational study
Eaton 1979	Observational study
Eaton 1984	Observational study
Eaton 1985	Observational study
Edmunds 1994	No intervention of interest
Egloff 2002	Observational study
Eiken 1970	Observational study
Esenwein 2011	No comparison of interest
Ferlic 1983	Observational study
Forseth 2003	No intervention of interest
Froimson 1987	Review
Fujiwara 2003	Observational study
Fulton 2001	Observational study
Furia 2010	No comparison of interest
Galli 2002	Observational study
Gallinet 2011	Observational study
Gangopadhyay 2008	Review
García-Mas 2009	Observational study
Gibbons 1999	Observational study

(*Continued*)

Goldberg 1994	Observational study
Gray 2007	Observational study
Haase 2011	Review
Hannula 1999	Observational study
Harrison 1977	Observational study
Hartigan 2001	Observational study
Hass 1989	Observational study
Hernández-Cortes 2012	Observational study
Herren 1997	Descriptive study
Hilty 1996	Observational study
Hobby 1998	Observational study
Hofammann 1987	Observational study
Hohendorff 2008	No comparison of interest
Hollevoet 1996	Descriptive study
Holmberg 1996	Observational study
Horlock 2002	No intervention of interest
Isselin 2001	Observational study
Johnston 2012	Observational study
Jörheim 2009	Observational study
Kaarela 1999	Observational study
Kapandji 2002	No intervention of interest
Karlsson 1990	Observational study
Kaszap 2012	Observational study
Kenniston 2008	Review

(*Continued*)

Kleinman 1991	Observational study
Kocheva 2011	Observational study
Kokkalis 2009	Observational study
Kuhns 2003	Observational study
Kuschner 1996	Review
Köhler 1987	Descriptive study
Lane 1987	Observational study
Lane 2001	Observational study
Lanzetta 1995	Observational study
Le Viet 1996	Observational study
Lehmann 1998	Descriptive study
Li 2011	Review
Lins 1996	Observational study
Linscheid 2000	Review
Lisanti 1997	Observational study
Liu 1999	Observational study
Lovell 1999	Observational study
MacDermid 2003	Observational study
Mandl 2006	No intervention of interest
Marmor 1969	Review
Marmor 1972	Review
Marti 2006	Observational study
Martinez de Aragon 2009	Observational study
Masmejean 2003	Observational study

(*Continued*)

McGovern 2001	Observational study
Menon 1995	Observational study
Mentzel 2001	Descriptive study
Messina 2000	No intervention of interest
Messina 2002	No intervention of interest
Mo 2004	Observational study
Molitor 1991	Observational study
Muermans 1998	Descriptive study
Mureau 2001	Descriptive study
Nakajima 1996	Observational study
Nilsson 2002	No intervention of interest
Nordback 2012	Observational study
Nusem 2003	Review
Nylén 1993	Observational study
O'Leary 1997	Observational study
O'Leary 2002	Observational study
Oka 2000	Observational study
Panciera 1997	Observational study
Pellegrini 1986	Observational study
Pellegrini 1996	No outcome of interest
Phaltankar 2003	Observational study
Punzi 2012	Review
Pérez-Úbeda 2003	Observational study
Rab 2006	Observational study

(*Continued*)

Raven 2007	Observational study
Rayan 1997	Observational study
Ritchie 2008	No comparison of interest
Roberts 2001	Observational study
Robinson 1991	Observational study
Saehle 2002	Observational study
Sakellarides 1989	Observational study
Sammer 2010	Observational study
Sandvall 2010	Observational study
Schmidt 1993	Observational study
Schröder 2002	Descriptive study
Schuhl 2001	Observational study
Smith 2002	Observational study
Smíd 2001	Descriptive study
Sotereanos 1993	Observational study
Stein 2011	Observational study
Stussi 2000	Descriptive study
Swanson 1983	Review
Søndergaard 1991	Observational study
Taghinia 2008	No comparison of interest
Takwale 2002	Observational study
Thomsen 2000	Observational study
Tomaino 1995	Observational study
Tomaino 2000	Observational study

(*Continued*)

Ulrich-Vinther 2008	Observational study
van Cappelle 1999	Observational study
van Cappelle 2001	Observational study
Van Giffen 2002	Observational study
Vandenbroucke 1997	Observational study
Vermeulen 2011	Review
Voulliaume 2003	Observational study
Wachtl 1997	Descriptive study
Wachtl 1998	Observational study
Wajon 2005	Review
Yang 1998	Observational study
Yao 2010	Observational study
Yao 2012	Descriptive study
Young 1998	Observational study
Young 2004	Review
Zancolli 2001	Review
Zollinger 2008	Observational study

Characteristics of studies awaiting assessment *[ordered by study ID]*

Hansen 2013

Methods	Randomised controlled, patient-blinded control trial Exp: Uncemented hydroxyapatite- coated chrome-cobalt Elektra screw cup C: DLC all-polyethylene cup
Participants	Age (mean): Exp/C = 60/56 Gender (female/male): Exp/C = 12:1/12:2 Stage of OA (mean): Exp/C = not stated

Hansen 2013 (*Continued*)

Interventions	Surgery Exp/C: Exp: Uncemented hydroxyapatite-coated chrome-cobalt Elektra screw cup. Three weeks immobilisation post-surgery. Return to full activities at 3 months C: DLC all-polyethylene cup. Three weeks immobilisation post-surgery. Return to full activities at 3 months
Outcomes	Pain: A 100 mm VAS was used to assess pain at rest and with activity Physical function: DASH score. Patient global assessment: Not reported. Range of motion: Not reported. Trapeziometacarpal joint imaging: Stereoradiographs to measure implant migration over time Adverse events: Not reported.
Notes	Follow-up at "3 months, 6 months, 12 months, and 24 months after the operation" Primary outcome of study was to measure implant migration.

C = control; Exp = experimental; OA = osteoarthritis.

DATA AND ANALYSES

Comparison 1. Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain - 100 mm VAS	3	162	Mean Difference (IV, Random, 95% CI)	-2.80 [-9.82, 4.21]
2 Pain - number of participants with resting pain	2	224	Risk Ratio (M-H, Random, 95% CI)	1.18 [0.31, 4.54]
3 Physical function - 0-100 with '0' = no disability	3	211	Std. Mean Difference (IV, Random, 95% CI)	0.01 [-0.30, 0.32]
4 Adverse events - number of participants with adverse events	4	328	Risk Ratio (M-H, Random, 95% CI)	1.89 [0.96, 3.73]
5 Trapeziometacarpal joint imaging - SMD at rest (mm)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
6 Range of motion - palmar abduction (cm)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
7 Range of motion - palmar abduction (degrees)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
8 Strength - tip pinch strength (kg)	2	213	Mean Difference (IV, Random, 95% CI)	0.13 [-0.26, 0.52]
9 Strength - lateral (key) pinch strength (kg)	4	325	Mean Difference (IV, Random, 95% CI)	0.11 [-0.18, 0.41]
10 Strength - grip strength (kg)	2	213	Mean Difference (IV, Random, 95% CI)	0.59 [-3.12, 4.29]

Comparison 2. Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain - number of participants with frequent or constant pain	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Physical function - number of participants with moderate difficulty with daily function	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Physical function - Buck Gramcko score (number of participants with good-excellent total score)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Adverse events - number of participants with adverse events	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5 Trapeziometacarpal joint imaging - SMD at rest (mm)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

6 Range of motion - palmar abduction (degrees)	2	51	Mean Difference (IV, Random, 95% CI)	-1.03 [-7.81, 5.75]
7 Strength - lateral (key) pinch strength (kg)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

Comparison 3. Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and interpositional arthroplasty (T and IA)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain - number of participants with resting pain	0		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Adverse events - Number of participants with adverse events	0		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
3 Strength - tip pinch strength (kg)	0		Mean Difference (IV, Random, 95% CI)	Totals not selected
4 Strength - lateral (key) pinch strength (kg)	0		Mean Difference (IV, Random, 95% CI)	Totals not selected
5 Strength - grip strength (kg)	0		Mean Difference (IV, Random, 95% CI)	Totals not selected

Comparison 4. Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain - 100 mm VAS during key pinch	2	77	Mean Difference (IV, Random, 95% CI)	-3.24 [-23.77, 17.29]
2 Pain - 100 mm VAS during tripod pinch	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3 Adverse events - mild to moderate swelling	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
4 Treatment failure - reoperation due to pain	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5 Range of motion - palmar abduction (degrees)	2	113	Mean Difference (IV, Random, 95% CI)	-4.13 [-11.16, 2.91]
6 Strength - lateral (key) pinch strength (kg)	2	113	Mean Difference (IV, Random, 95% CI)	-1.09 [-2.40, 0.22]
7 Strength - pinch (tripod) strength (kg)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
8 Strength - grip strength (kg)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

Comparison 5. Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain - 100 mm VAS	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
2 Adverse events - number of participants with adverse events	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Trapeziometacarpal joint imaging - SMD at rest (mm)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
4 Range of motion - palmar abduction (degrees)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
5 Strength - lateral (key) pinch strength (kp/cm^2)	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

Comparison 6. Trapeziectomy with interpositional arthroplasty (T and IA) versus trapeziectomy (T)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain - number of participants with resting pain	0		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2 Adverse events - number of participants with adverse events	0		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3 Strength - lateral pinch strength (kg)	0		Mean Difference (IV, Random, 95% CI)	Totals not selected
4 Strength - tip pinch strength (kg)	0		Mean Difference (IV, Random, 95% CI)	Totals not selected
5 Strength - grip strength (kg)	0		Mean Difference (IV, Random, 95% CI)	Totals not selected

Analysis 1.1. Comparison 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), Outcome 1 Pain - 100 mm VAS.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

Outcome: 1 Pain - 100 mm VAS

Study or subgroup	T and LRTI N	Mean(SD)	T N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Belcher 2000	23	40 (28.77)	19	37 (26.15)		17.8 %	3.00 [-13.63, 19.63]
De Smet 2004	34	24 (20.5)	21	32.5 (23.3)		33.5 %	-8.50 [-20.62, 3.62]
Field 2007	33	15 (18)	32	16 (23)		48.6 %	-1.00 [-11.06, 9.06]
Total (95% CI)	**90**		**72**			**100.0 %**	**-2.80 [-9.82, 4.21]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 1.44$, df = 2 (P = 0.49); $I^2 = 0.0\%$

Test for overall effect: Z = 0.78 (P = 0.43)

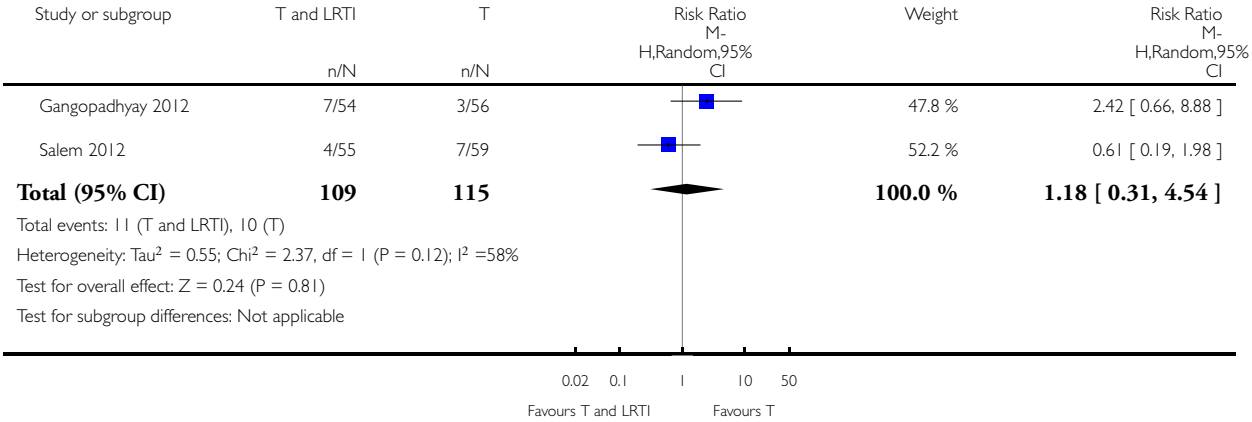
Test for subgroup differences: Not applicable

Analysis 1.2. Comparison 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), Outcome 2 Pain - number of participants with resting pain.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

Outcome: 2 Pain - number of participants with resting pain



Analysis 1.3. Comparison 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), Outcome 3 Physical function - 0-100 with '0' = no disability.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

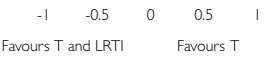
Outcome: 3 Physical function - 0-100 with '0' = no disability

Study or subgroup	T and LRTI N	Mean(SD)	T N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
Belcher 2000	23	39 (23.98)	19	30 (17.44)		22.4 %	0.41 [-0.20, 1.03]
De Smet 2004	34	27 (22.79)	21	33 (29.64)		27.4 %	-0.23 [-0.78, 0.31]
Salem 2012	55	30 (29.5926)	59	31 (19.1864)		50.2 %	-0.04 [-0.41, 0.33]
Total (95% CI)	**112**		**99**			**100.0 %**	**0.01 [-0.30, 0.32]**

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 2.48$, df = 2 (P = 0.29); $I^2 = 19\%$

Test for overall effect: Z = 0.06 (P = 0.95)

Test for subgroup differences: Not applicable

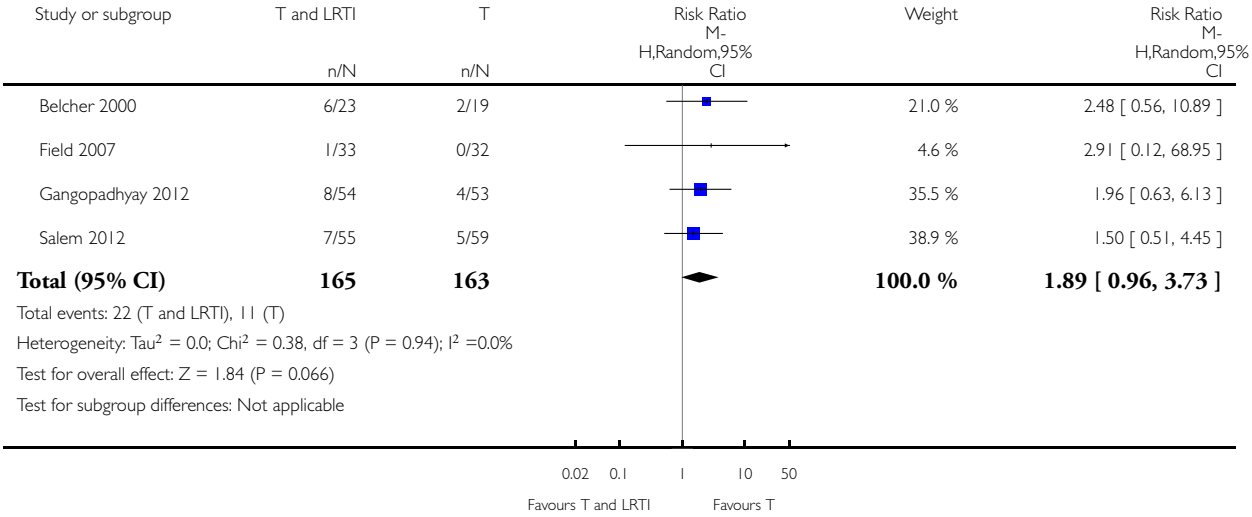


Analysis 1.4. Comparison 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), Outcome 4 Adverse events - number of participants with adverse events.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

Outcome: 4 Adverse events - number of participants with adverse events

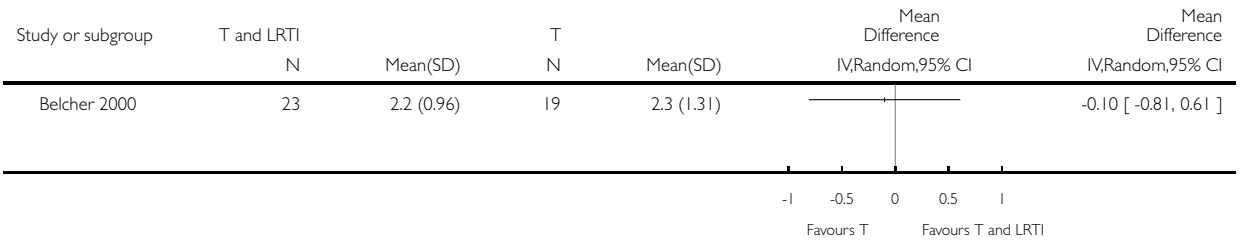


Analysis 1.5. Comparison 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), Outcome 5 Trapeziometacarpal joint imaging - SMD at rest (mm).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

Outcome: 5 Trapeziometacarpal joint imaging - SMD at rest (mm)



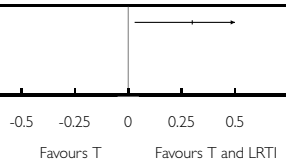
Analysis 1.6. Comparison 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), Outcome 6 Range of motion - palmar abduction (cm).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

Outcome: 6 Range of motion - palmar abduction (cm)

Study or subgroup	T and LRTI N	Mean(SD)	T N	Mean(SD)	Mean Difference IV,Random,95% CI	Mean Difference IV,Random,95% CI
Belcher 2000	23	4.6 (0.5)	19	4.3 (0.4)		0.30 [0.03, 0.57]



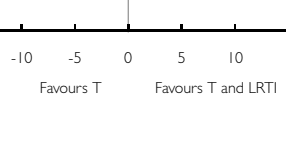
Analysis 1.7. Comparison 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), Outcome 7 Range of motion - palmar abduction (degrees).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

Outcome: 7 Range of motion - palmar abduction (degrees)

Study or subgroup	T and LRTI N	Mean(SD)	T N	Mean(SD)	Mean Difference IV,Random,95% CI	Mean Difference IV,Random,95% CI
Field 2007	33	62 (12.64)	32	54 (14.14)		8.00 [1.47, 14.53]



Analysis 1.8. Comparison 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), Outcome 8 Strength - tip pinch strength (kg).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

Outcome: 8 Strength - tip pinch strength (kg)

Study or subgroup	T and LRTI N	Mean(SD)	T N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Gangopadhyay 2012	54	3.85 (1.705)	53	3.85 (1.705)		36.4 %	0.0 [-0.65, 0.65]
Salem 2012	51	3 (1.0666)	55	2.8 (1.4796)		63.6 %	0.20 [-0.29, 0.69]
Total (95% CI)	**105**		**108**			**100.0 %**	**0.13 [-0.26, 0.52]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.23$, df = 1 (P = 0.63); $I^2 = 0.0\%$

Test for overall effect: Z = 0.64 (P = 0.52)

Test for subgroup differences: Not applicable

Analysis 1.9. Comparison 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), Outcome 9 Strength - lateral (key) pinch strength (kg).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

Outcome: 9 Strength - lateral (key) pinch strength (kg)

Study or subgroup	T and LRTI N	Mean(SD)	T N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Belcher 2000	23	4 (1.4)	19	3.7 (1.7)		9.5 %	0.30 [-0.65, 1.25]
Field 2007	30	8.1 (3.5)	32	8.6 (4)		2.5 %	-0.50 [-2.37, 1.37]
Gangopadhyay 2012	54	2.55 (1.112)	53	2.5 (1.038)		52.0 %	0.05 [-0.36, 0.46]
Salem 2012	55	3 (1.1097)	59	2.8 (1.5349)		36.1 %	0.20 [-0.29, 0.69]
Total (95% CI)	**162**		**163**			**100.0 %**	**0.11 [-0.18, 0.41]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.77$, df = 3 (P = 0.86); $I^2 = 0.0\%$

Test for overall effect: Z = 0.76 (P = 0.45)

Test for subgroup differences: Not applicable

Analysis 1.10. Comparison 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T), Outcome 10 Strength - grip strength (kg).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 1 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy (T)

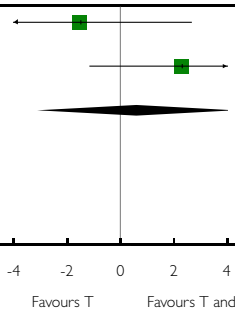
Outcome: 10 Strength - grip strength (kg)

Study or subgroup	T and LRTI N	Mean(SD)	T N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Gangopadhyay 2012	54	18 (13.34)	53	19.5 (8.154)		45.1 %	-1.50 [-5.68, 2.68]
Salem 2012	55	24.1 (9.9875)	51	21.8 (8.1776)		54.9 %	2.30 [-1.16, 5.76]
Total (95% CI)	**109**		**104**			**100.0 %**	**0.59 [-3.12, 4.29]**

Heterogeneity: $Tau^2 = 3.38$; $Chi^2 = 1.88$, df = 1 (P = 0.17); $I^2 = 47\%$

Test for overall effect: Z = 0.31 (P = 0.76)

Test for subgroup differences: Not applicable

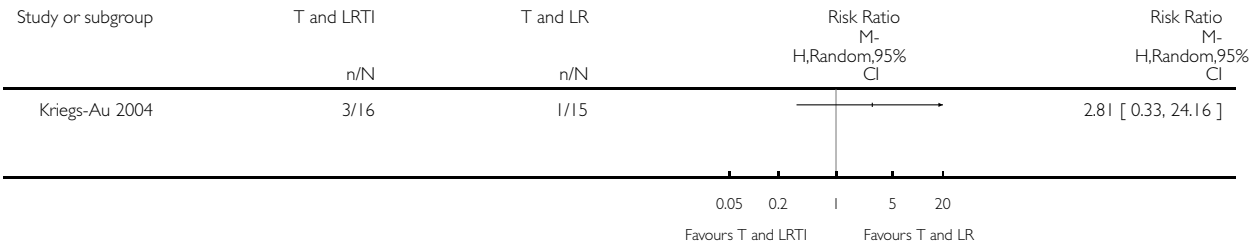


Analysis 2.1. Comparison 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR), Outcome 1 Pain - number of participants with frequent or constant pain.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR)

Outcome: 1 Pain - number of participants with frequent or constant pain

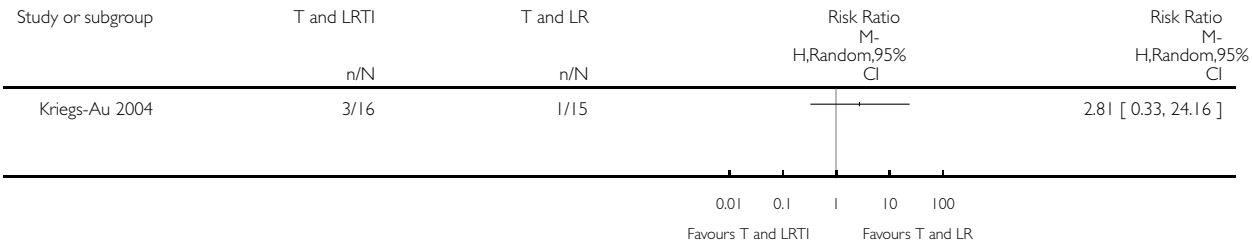


Analysis 2.2. Comparison 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR), Outcome 2 Physical function - number of participants with moderate difficulty with daily function.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR)

Outcome: 2 Physical function - number of participants with moderate difficulty with daily function

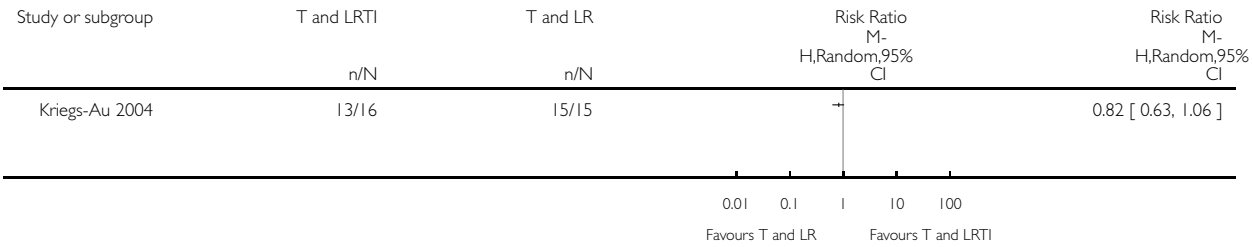


Analysis 2.3. Comparison 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR), Outcome 3 Physical function - Buck Gramcko score (number of participants with good-excellent total score).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR)

Outcome: 3 Physical function - Buck Gramcko score (number of participants with good-excellent total score)

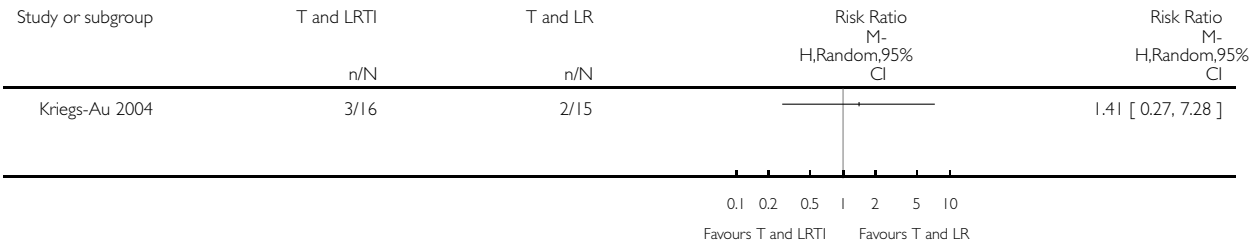


Analysis 2.4. Comparison 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR), Outcome 4 Adverse events - number of participants with adverse events.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR)

Outcome: 4 Adverse events - number of participants with adverse events



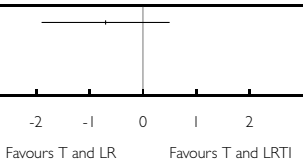
Analysis 2.5. Comparison 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR), Outcome 5 Trapeziometacarpal joint imaging - SMD at rest (mm).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR)

Outcome: 5 Trapeziometacarpal joint imaging - SMD at rest (mm)

Study or subgroup	T and LRTI		T and LR		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI	IV,Random,95% CI
Gerwin 1997	9	4.5 (1)	11	5.2 (1.7)		-0.70 [-1.90, 0.50]



Analysis 2.6. Comparison 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR), Outcome 6 Range of motion - palmar abduction (degrees).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR)

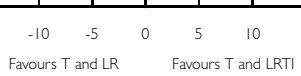
Outcome: 6 Range of motion - palmar abduction (degrees)

Study or subgroup	T and LRTI		T and LR		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI		IV,Random,95% CI
Gerwin 1997	9	47 (6)	11	44 (8)		42.5 %	3.00 [-3.14, 9.14]
Kriegs-Au 2004	16	38 (4.4)	15	42 (4.3)		57.5 %	-4.00 [-7.06, -0.94]
Total (95% CI)	**25**		**26**			**100.0 %**	**-1.03 [-7.81, 5.75]**

Heterogeneity: $Tau^2 = 18.37$; $Chi^2 = 4.00$, df = 1 (P = 0.05); $I^2 = 75\%$

Test for overall effect: Z = 0.30 (P = 0.77)

Test for subgroup differences: Not applicable



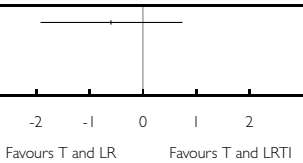
Analysis 2.7. Comparison 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR), Outcome 7 Strength - lateral (key) pinch strength (kg).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 2 Trapeziectomy with ligament reconstruction and tendon interposition (T and LRTI) versus trapeziectomy and ligament reconstruction (T and LR)

Outcome: 7 Strength - lateral (key) pinch strength (kg)

Study or subgroup	T and LRTI		T and LR		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI	IV,Random,95% CI
Gerwin 1997	9	4.8 (1.6)	11	5.4 (1.4)		-0.60 [-1.93, 0.73]



Analysis 4.1. Comparison 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant, Outcome 1 Pain - 100 mm VAS during key pinch.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant

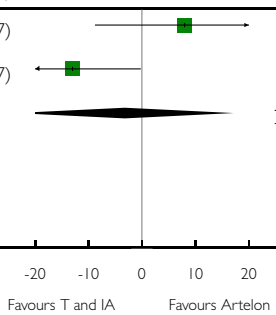
Outcome: 1 Pain - 100 mm VAS during key pinch

Study or subgroup	T and IA		Artelon Implant		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI		IV,Random,95% CI
Nilsson 2005	5	12 (17.9)	10	4 (9.7)		46.5 %	8.00 [-8.80, 24.80]
Nilsson 2010	26	13 (24)	36	26 (27)		53.5 %	-13.00 [-25.76, -0.24]
Total (95% CI)	**31**		**46**			**100.0 %**	**-3.24 [-23.77, 17.29]**

Heterogeneity: $Tau^2 = 162.55$; $Chi^2 = 3.81$, df = 1 (P = 0.05); $I^2 = 74\%$

Test for overall effect: Z = 0.31 (P = 0.76)

Test for subgroup differences: Not applicable



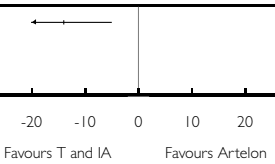
Analysis 4.2. Comparison 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant, Outcome 2 Pain - 100 mm VAS during tripod pinch.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant

Outcome: 2 Pain - 100 mm VAS during tripod pinch

Study or subgroup	T and IA		Artelon Implant		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI	IV,Random,95% CI
Nilsson 2010	35	12 (20)	63	26 (25)		-14.00 [-23.06, -4.94]



Analysis 4.3. Comparison 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant, Outcome 3 Adverse events - mild to moderate swelling.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant

Outcome: 3 Adverse events - mild to moderate swelling

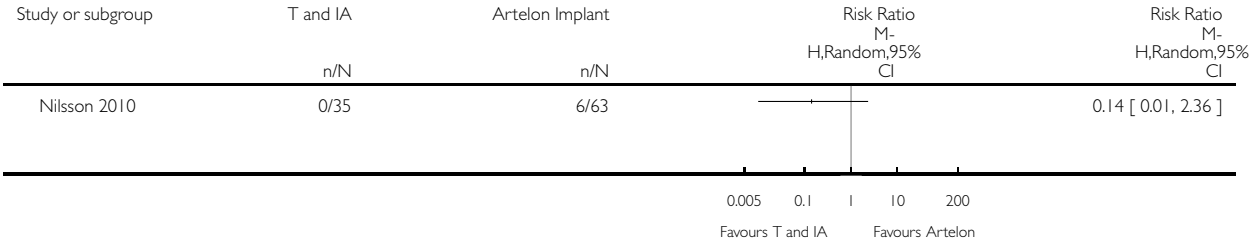
Study or subgroup	T and IA	Artelon Implant	Risk Ratio M-H,Random,95% CI	Risk Ratio M-H,Random,95% CI
	n/N	n/N		
Nilsson 2010	1/35	21/63		0.09 [0.01, 0.61]

Analysis 4.4. Comparison 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant, Outcome 4 Treatment failure - reoperation due to pain.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant

Outcome: 4 Treatment failure - reoperation due to pain

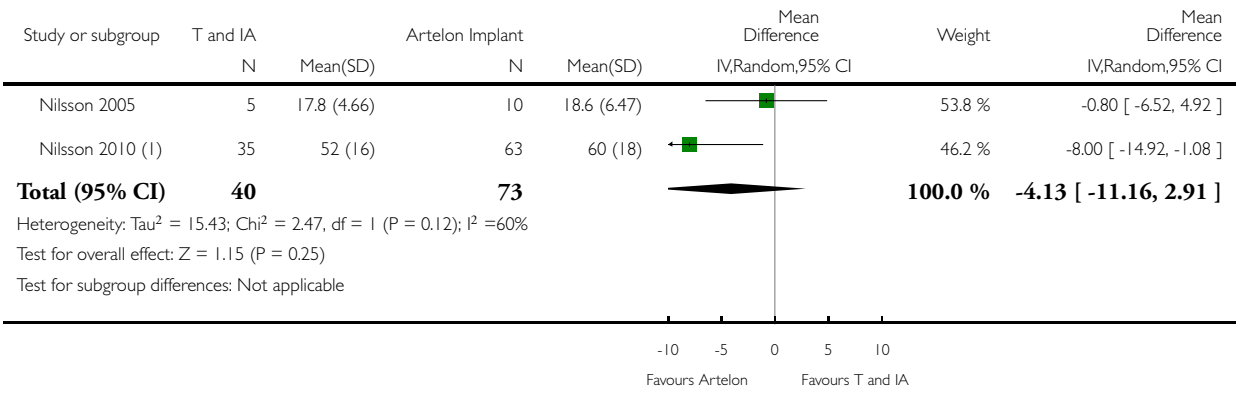


Analysis 4.5. Comparison 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant, Outcome 5 Range of motion - palmar abduction (degrees).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant

Outcome: 5 Range of motion - palmar abduction (degrees)



(1) Per-protocol data

Analysis 4.6. Comparison 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant, Outcome 6 Strength - lateral (key) pinch strength (kg).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant

Outcome: 6 Strength - lateral (key) pinch strength (kg)

Study or subgroup	T and IA N	Mean(SD)	Artelon Implant N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Nilsson 2005	5	5.3 (1.3)	10	7.3 (2.25)		35.0 %	-2.00 [-3.80, -0.20]
Nilsson 2010	35	5.2 (2)	63	5.8 (3)		65.0 %	-0.60 [-1.59, 0.39]
Total (95% CI)	**40**		**73**			**100.0 %**	**-1.09 [-2.40, 0.22]**

Heterogeneity: $Tau^2 = 0.43$; $Chi^2 = 1.78$, df = 1 (P = 0.18); $I^2 = 44\%$

Test for overall effect: Z = 1.63 (P = 0.10)

Test for subgroup differences: Not applicable

Analysis 4.7. Comparison 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant, Outcome 7 Strength - pinch (tripod) strength (kg).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant

Outcome: 7 Strength - pinch (tripod) strength (kg)

Study or subgroup	T and IA N	Mean(SD)	Artelon Implant N	Mean(SD)	Mean Difference IV,Random,95% CI	Mean Difference IV,Random,95% CI
Nilsson 2010	35	5 (2.1)	63	5.7 (3.5)		-0.70 [-1.81, 0.41]

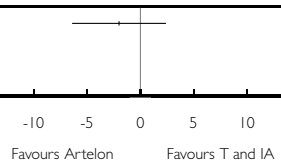
Analysis 4.8. Comparison 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant, Outcome 8 Strength - grip strength (kg).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 4 Trapeziectomy with interpositional arthroplasty (T and IA) versus Artelon implant

Outcome: 8 Strength - grip strength (kg)

Study or subgroup	T and IA		Artelon Implant		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI	IV,Random,95% CI
Nilsson 2010	35	22 (11)	63	24 (10)		-2.00 [-6.40, 2.40]



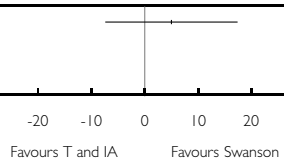
Analysis 5.1. Comparison 5 Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson), Outcome 1 Pain - 100 mm VAS.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 5 Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson)

Outcome: 1 Pain - 100 mm VAS

Study or subgroup	T and IA		Swanson		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI	IV,Random,95% CI
Tagil 2002	13	14 (20)	13	9 (11)		5.00 [-7.41, 17.41]

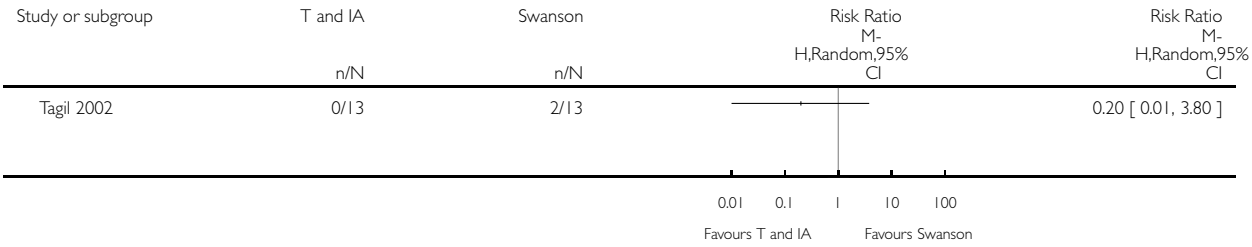


Analysis 5.2. Comparison 5 Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson), Outcome 2 Adverse events - number of participants with adverse events.

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 5 Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson)

Outcome: 2 Adverse events - number of participants with adverse events

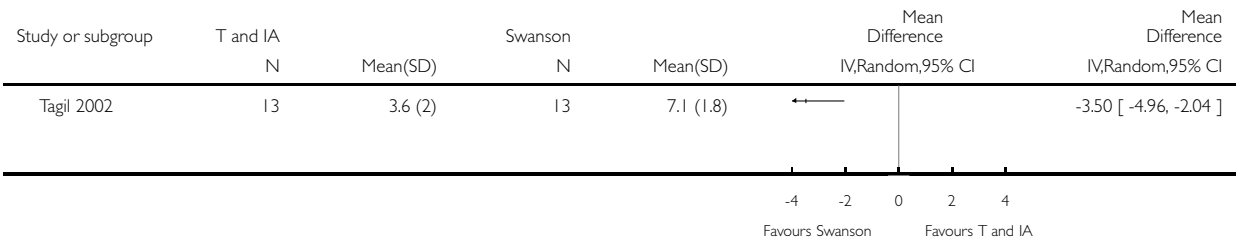


Analysis 5.3. Comparison 5 Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson), Outcome 3 Trapeziometacarpal joint imaging - SMD at rest (mm).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 5 Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson)

Outcome: 3 Trapeziometacarpal joint imaging - SMD at rest (mm)



Analysis 5.4. Comparison 5 Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson), Outcome 4 Range of motion - palmar abduction (degrees).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 5 Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson)

Outcome: 4 Range of motion - palmar abduction (degrees)

Study or subgroup	T and IA		Swanson		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI	IV,Random,95% CI
Tagil 2002	13	36 (6)	13	34 (7)		2.00 [-3.01, 7.01]

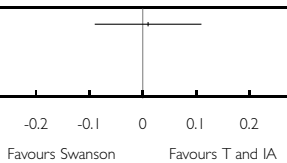
Analysis 5.5. Comparison 5 Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson), Outcome 5 Strength - lateral (key) pinch strength (kp/cm2).

Review: Surgery for thumb (trapeziometacarpal joint) osteoarthritis

Comparison: 5 Trapeziectomy with interpositional arthroplasty (T and IA) versus Trapeziometacarpal joint replacement (Swanson)

Outcome: 5 Strength - lateral (key) pinch strength (kp/cm^2)

Study or subgroup	T and IA		Swanson		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI	IV,Random,95% CI
Tagil 2002	13	0.25 (0.11)	13	0.24 (0.14)		0.01 [-0.09, 0.11]



ADDITIONAL TABLES

Table 1. Adverse events of trapeziectomy and LRTI versus trapeziectomy

Study	Group	Tendon rupture/ adhesion	Scar tenderness or infection	Recurrent pain	Sensory change	Cut PCMN	Neuroma	Instability	De Quervain's Disease	CRPS (type 1)
Belcher 2000	Trapeziectomy (n = 19)	-	-	1	-	-	1	-	-	-
	Trapeziectomy and LRTI (n = 23)	1	-	2	1		1	1	-	-
De Smet 2004	Trapeziectomy (n = 21)	-	-	-	-	-	-	1	-	-
	Trapeziectomy and LRTI (n = 34)	-	-	-	-	-	-	-	-	-
Field 2007	Trapeziectomy (n = 32)	-	2	-	1	-	-	-	-	1
	Trapeziectomy and LRTI (n = 33)	6	1	-	1	-	-	-	-	4
Gangopadhyay 2012	Trapeziectomy (n = 53)	-	-	-	2	2	-	-	-	-
	Trapeziectomy and LRTI (n = 54)	2	2	-	2	2	-	-	-	-

Table 1. Adverse events of trapeziectomy and LRTI versus trapeziectomy (*Continued*)

Salem 2012	Trapeziectomy (n = 21)	-	-	-	-	3	-	-	1	1
	Trapeziectomy and LRTI (n = 27)	1	1	-	4	-	-	-	1	-

Cut PCMN = cut palmar cutaneous branch of median nerve; CRPS = Complex Regional Pain Syndrome.

Table 2. Adverse effects of trapeziectomy and LRTI versus LR

Study	Group	CRPS (type 1)
Kriegs-Au 2004	Trapeziectomy and LRTI (n = 16)	1
	Trapeziectomy and LR (n = 15)	-

Cut PCMN = cut palmar cutaneous branch of median nerve; CRPS = Complex Regional Pain Syndrome.

Table 3. Adverse effects of trapeziectomy and LRTI versus IA

Study	Group	Tendon rupture/ adhesion	Scar tenderness	Sensory change	Cut PCMN
Gangopadhyay 2012	Trapeziectomy and IA (n = 46)	1	-	2	2
	Trapeziectomy and LRTI (n = 54)	2	2	2	2

Cut PCMN = cut palmar cutaneous branch of median nerve
CRPS = Complex Regional Pain Syndrome

Table 4. Adverse events of trapeziectomy and IA versus Artelon implant

Study	Group	Mild to moderate swelling	Re-operation due to pain
Nilsson 2010	Trapeziectomy and IA (n = 35)	1	1
	Artelon implant (n = 63)	-	6

Table 5. Adverse events of trapeziectomy and LRTI versus Swanson joint replacement

Study	Group	Instability	CRPS (type 1)
Tagil 2002	Swanson (n = 13)	2	-
	Trapeziectomy and IA (n = 13)	-	-

Cut PCMN = cut palmar cutaneous branch of median nerve
CRPS = Complex Regional Pain Syndrome

Table 6. Adverse events of trapeziectomy and IA versus trapeziectomy

Study	Group	Tendon rupture/adhesion	Sensory change	Cut PCMN
Gangopadhyay 2012	Trapeziectomy (n = 53)	-	2	2
	Trapeziectomy and IA (n = 46)	1	2	2

Cut PCMN = cut palmar cutaneous branch of median nerve; CRPS = Complex Regional Pain Syndrome.

APPENDICES

Appendix 1. COCHRANE search strategy

#1 MeSH descriptor Osteoarthritis explode all trees
#2 osteoarthr*:ti,ab
#3 (degenerative next arthritis):ti,ab
#4 arthrosis:ti,ab
#5 (#1 OR #2 OR #3 OR #4)
#6 MeSH descriptor Thumb explode all trees
#7 thumb*:ti,ab
#8 trapeziometacarpal:ti,ab
#9 (carpometacarpal or (carpal next metacarpal)):ti,ab
#10 ((cmc or basal) next joint*):ti,ab
#11 (#6 OR #7 OR #8 OR #9 OR #10)
#12 MeSH descriptor Orthopedics explode all trees
#13 MeSH descriptor Surgery, Plastic explode all trees
#14 Any MeSH descriptor with qualifier: SU
#15 (surgery* or surgeries or surgical or operat*):ti,ab
#16 (arthroplast* or (joint * near /2 replace*)):ti,ab
#17 ligamentoplast*:ti,ab
#18 lrti:ti,ab
#19 (reconstruct* or interposition):ti,ab

#20 suspension*:ti,ab
#21 trapeziectom*:ti,ab
#22 (artelon or spacer*):ti,abe
#23 (arthrodesis or fusion or osteotom*):ti,ab
#24 (artelon or spacer* or pyrocarbon):ti,ab
#25 (#12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24)
#26 (#5 AND #11 AND #25)

Appendix 2. MEDLINE search strategy

1. exp osteoarthritis/
2. osteoarthr$.tw.
3. (degenerative adj2 arthritis).tw.
4. arthrosis.tw.
5. or/1-4
6. thumb/
7. thumb$.tw.
8. trapeziometacarpal.tw.
9. (carpometacarpal or (carpal adj metacarpal)).tw.
10. ((cmc or basal) adj joint$).tw.
11. or/6-10
12. exp surgery/
13. exp Surgical Procedures, Operative/
14. su.fs.
15. (surgery$ or surgeries or surgical or operat$).tw.
16. (arthroplast$ or (joint$ adj2 replace$)).tw.
17. ligamentoplast$.tw.
18. lrti.tw.
19. (reconstruct$ or interposition).tw.
20. suspension$.tw.
21. trapeziectom$.tw.
22. (artelon or spacer$ or pyrocarbon).tw.
23. (arthrodesis or fusion or osteotom$).tw.
24. or/12-23
25. and/5,11,24
26. randomized controlled trial.pt.
27. controlled clinical trial.pt.
28. randomized.ab.
29. placebo.ab.
30. randomly.ab.
31. trial.ab.
32. groups.ab.
33. double blind method.sh.
34. single-blind method.sh.
35. ((doubl$ adj blind) or (doubl$ adj mask)).ti,ab.
36. ((singl$ adj blind) or (singl$ adj mask)).ti,ab.
37. 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36
38. 25 and 37

Appendix 3. EMBASE search strategy

1. exp osteoarthritis/
2. osteoarthr$.tw.
3. (degenerative adj2 arthritis).tw.
4. arthrosis.tw.
5. or/1-4
6. Thumb/
7. thumb$.tw.
8. trapeziometacarpal.tw.
9. (carpometacarpal or (carpal adj metacarpal)).tw.
10. ((cmc or basal) adj joint$).tw.
11. or/6-10
12. exp Surgery/
13. su.fs.
14. (surgery$ or surgeries or surgical or operat$).tw.
15. (arthroplast$ or (joint$ adj2 replace$)).tw.
16. ligamentoplast$.tw.
17. lrti.tw.
18. (reconstruct$ or interposition).tw.
19. suspension$.tw.
20. trapeziectom$.tw.
21. (artelon or spacer$ or pyrocarbon).tw.
22. (arthrodesis or fusion or osteotom$).tw.
23. or/12-22
24. random$.ti,ab.
25. factorial$.ti,ab.
26. (crossover$ or cross over$ or cross-over$).ti,ab.
27. placebo$.ti,ab.
28. ((doubl$ adj blind$) or (doubl$ adj mask$)).ti,ab.
29. ((singl$ adj blind$) or (singl$ adj mask$)).ti,ab.
30. crossover procedure.sh.
31. double blind procedure.sh.
32. randomized controlled trial.sh.
33. single blind procedure.sh.
34. 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33
35. 5 and 11 and 23 and 34

Appendix 4. CINAHL search strategy

	Query
S24	S23 and S12 and S5
S23	S22 or S21 or S20 or S19 or S18 or S17 or S16 or S15 or S14 or S13
S22	TI (arthrodesis or fusion or osteotom*) or AB (arthrodesis or fusion or osteotom*)
S21	TI (artelon or spacer* or pyrocarbon) or AB (artelon or spacer* or pyrocarbon)

(*Continued*)

S20	TI trapeziectom* or AB trapeziectom*
S19	TI suspension* or AB suspension*
S18	TI (reconstruct* or interposition) or AB (reconstruct* or interposition)
S17	TI lrti or AB lrti
S16	TI ligamentoplast* or AB ligamentoplast*
S15	TI arthroplast* or AB arthroplast* or TI joint* N2 replace* or AB joint* N2 replace*
S14	TI (surgery* or surgeries or surgical or operat*) or AB (surgery* or surgeries or surgical or operat*)
S13	(MH "Surgery, Operative+")
S12	S11 or S10 or S9 or S8 or S7 or S6
S11	AB ((cmc or basal)) and AB joint*
S10	TI ((cmc or basal)) and TI joint*
S9	TI carpometacarpal or AB carpometacarpal or TI carpal metacarpal or AB carpal metacarpal
S8	TI trapeziometacarpal or AB trapeziometacarpal
S7	TI thumb* and AB thumb*
S6	(MH "Thumb")
S5	S4 or S3 or S2 or S1
S4	(ti arthrosis) or (ab arthrosis)
S3	(ti degenerative N2 arthritis) or (ab degenerative N2 arthritis)
S2	(ti osteoarthr*) or (ab osteoarthr*)
S1	(MH "Osteoarthritis+")

Appendix 5. ClinicalTrials.gov search strategy

trapeziometacarpal or thumb

Appendix 6. WHO Trials Portal search strategy

trapeziometacarpal or thumb

WHAT'S NEW

Last assessed as up-to-date: 14 October 2013.

Date	Event	Description
21 March 2017	Amended	We are temporarily withdrawing this review from the Cochrane Library whilst the authors respond to internal comments

HISTORY

Protocol first published: Issue 1, 2004

Review first published: Issue 4, 2005

Date	Event	Description
2 March 2015	Amended	Amended text to clarify that no studies were identified that compared surgery to sham surgery or to non-surgical interventions
23 April 2014	New citation required but conclusions have not changed	We updated review, with no changes to the conclusions, and added a new review author
14 October 2013	New search has been performed	We searched for new studies up to 08 August 2013 and included four new trials (Gangopadhyay 2012; Hansen 2013; Nilsson 2010; Salem 2012). We updated the Methods, Results and Discussion sections in accordance with current Cochrane Collaboration recommendations, and to align with the conduct and reporting standards recommended by the Cochrane Collaboration's Methodological Expectations of Cochrane Intervention Reviews (MECIR) project
13 August 2009	New citation required but conclusions have not changed	Substantive amendment and addition of new author.

(*Continued*)

31 January 2009	New search has been performed	We searched for new studies to the end of 2008 and identified three new trials that met the inclusion criteria (Field 2007; Hart 2006; Nilsson 2005). We excluded one trial that was previously included (Belcher 2001) because the study was terminated early due to adverse events and data were not available at 12 months The methods section was updated to reflect current Cochrane Collaboration guidelines to incorporate 'Risk of bias' and 'Summary of findings' tables
2 April 2008	Amended	CMSG ID C084-R
2 April 2008	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

AW, IE and LA conceived and designed the original review. AW coordinated the review, designed the search strategies and performed the searches. AW and IE screened and appraised the quality of retrieved papers. AW extracted data from the papers, entered data into RevMan 2014, analysed the data and interpreted results. AW and EC updated the review in 2009. TV and AW updated the review in 2013.

AW is the guarantor for the review.

DECLARATIONS OF INTEREST

We have no known conflicts of interest.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We have updated the Methods section since the original protocol was published, in accordance with the current recommended methods of The Cochrane Collaboration and the Cochrane Musculoskeletal Group. The main change we introduced was an adjustment to the primary outcomes and the secondary outcomes. In this review the primary outcomes were pain, physical function, quality of life, participant global assessment, adverse events, treatment failure and radiographic outcomes. Secondary outcomes were range of movement and strength.

For this review, we updated the search methodology which is reflected on in the Methods section and Search strategy appendices. We maintained all references identified by previous searches in this review.

Two review authors (TV and LA) contributed to this review since the publication of the original protocol.

NOTES

We are temporarily withdrawing this review from the Cochrane Library whilst the authors respond to internal comments.

INDEX TERMS

Medical Subject Headings (MeSH)

Hand Joints [*surgery]; Metacarpus [*surgery]; Osteoarthritis [*surgery]; Randomized Controlled Trials as Topic; Range of Motion, Articular; Recovery of Function; Thumb [*surgery]; Trapezium Bone [*surgery]

MeSH check words

Humans