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Guideline on managing thumb base osteoarthritis: The British Society for Surgery of the Hand Evidence for Surgical Treatment (BEST) findings and recommendations

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Abstract

This review paper provides a summary of the evidence for non-surgical and surgical management of thumb base osteoarthritis and suggests guidelines through *Clinical Practice Recommendations* including *Good Practice Points* and a *Patient Flow Algorithm*. The guidelines were developed through systematic reviews in accordance with the British Society for Surgery of the Hand Evidence for Surgical Treatment (BEST) Process Manual, which has been accredited by the National Institute for Health and Care Excellence. A stepwise approach is recommended with initial non-invasive treatment consisting of a comprehensive and multimodal package of supported self-management. Splints should be additionally considered for those who have not responded to a self-management package alone. Intra-articular corticosteroid injections should be considered in those who have not responded to non-invasive treatment. If symptoms fail to resolve, surgery should be considered. Additional procedures such as interposition or ligament reconstruction do not appear to confer any benefit over excision of the trapezium alone.

Keywords

Guideline, injection, osteoarthritis, thumb, therapy, trapezio-metacarpal, trapeziectomy

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Introduction

Thumb base osteoarthritis (TBOA) is a common problem (Eaton et al., 2022). The aim of treatment is to reduce pain and improve function. It is universally agreed that the initial management of TBOA should be non-surgical, involving hand therapy techniques (patient education, activity modification, hand exercises, oral and topical analgesia, heat, ice and splints), sometimes supplemented by injection of a therapeutic substance (commonly corticosteroid) into the joint space and if symptoms persist, surgery is offered (Challoumas et al., 2022; Wajon et al., 2015).

The provision and content of non-surgical management and the timing and choice of surgical procedures remain variable across regions, not only in the UK but across the world. Some of this variation is

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due to logistic reasons, such as availability of expertise and funding. In addition, there is a lack of high quality, evidence-based guidelines to help manage this common condition.

This paper presents the British Society for Surgery of the Hand Evidence for Surgical Treatment (BEST) Guidelines on the management of TBOA, which has been accredited by the National Institute for Health and Care Excellence (NICE). As a summary version of the full document (Supplementary material 1), key findings from the systematic reviews and recommendations for practice are described. The full version with hyperlinks to resources is also available to view and download from the British Society for Surgery of the Hand (BSSH) website (bssh.ac.uk – Evidence based management of adults with thumb base osteoarthritis).

Methods

Aims and objectives

The aim of these guidelines is to provide an overview of the best evidence for non-surgical and surgical management of adult patients with TBOA and suggest an evidence-based pathway for managing TBOA from primary care in the community, through to secondary care in the hospital.

Target audience

The anticipated users are health care professionals treating patients with TBOA, those commissioning care for these patients and possibly the patients themselves.

Process of guideline development

The guidelines were produced by systematic reviews, with the interpretation and development of recommendations achieved by consensus of the Guideline Development Group members. The process of developing the guidelines is defined in the BSSH BEST Process Manual (Rodrigues and Davis, 2016). This included assembling a group of stakeholders (patient representatives and medical professionals from the relevant specialities), developing key questions, conducting the systematic reviews, critically appraising the evidence, and finally agreeing and writing up the guidelines. The systematic review protocol was registered with PROSPERO (international prospective register of systematic reviews) (CRD42018114966). The evidence was appraised and synthesised into guidelines following the process and using the methodology and tools in the SIGN 50 manual (SIGN 50, 2019). The guidelines were then circulated for review by relevant stakeholder organizations including the BSSH, British Association of Hand Therapists, the British Society for Rheumatology, the British Orthopaedic Association and the British Association of Plastic, Reconstructive and Aesthetic Surgeons. This process of developing the guidelines has been accredited by NICE.

Key questions

The management of TBOA was divided into three main categories – non-invasive treatment, joint injection and surgery. The key questions for the systematic reviews were:

1. Are non-invasive treatments such as education, exercise and splints, effective in treating TBOA?
2. Are steroid injections effective in treating TBOA?
3. Are surgical treatments effective for TBOA?

Database search strategy

Our initial search criteria were broad to identify the widest range of available evidence for treating TBOA. This was further refined by adding specific terms for education, exercise, splinting, joint injections and surgical treatment. The databases searched were Cochrane Library, Pubmed, Embase and Medline. The main search was conducted on 1 December 2018 and later updated using the same criteria on 20 March 2021. Full details of the searches with MeSH terms can be found in the final guideline (Supplementary material 1).

Included studies were randomized controlled trials (RCTs) and systematic reviews of randomized controlled trials of treatment options for TBOA in adults over 18 years of age. Cohort studies, case–control studies and studies of post-traumatic or inflammatory arthritis were excluded.

Database search results

Figure 1 depicts the results of the searches. Forty-eight papers were included in our final review: non-invasive, 22; injections, 12; and surgery, 15. The eligible papers were assessed in accordance with the SIGN50 methodology.

Results and discussion

The results of the systematic reviews are discussed for each key question.

Non-invasive treatment

Six systematic reviews, 11 RCTs, one pilot RCT and four randomised crossover trials were included.

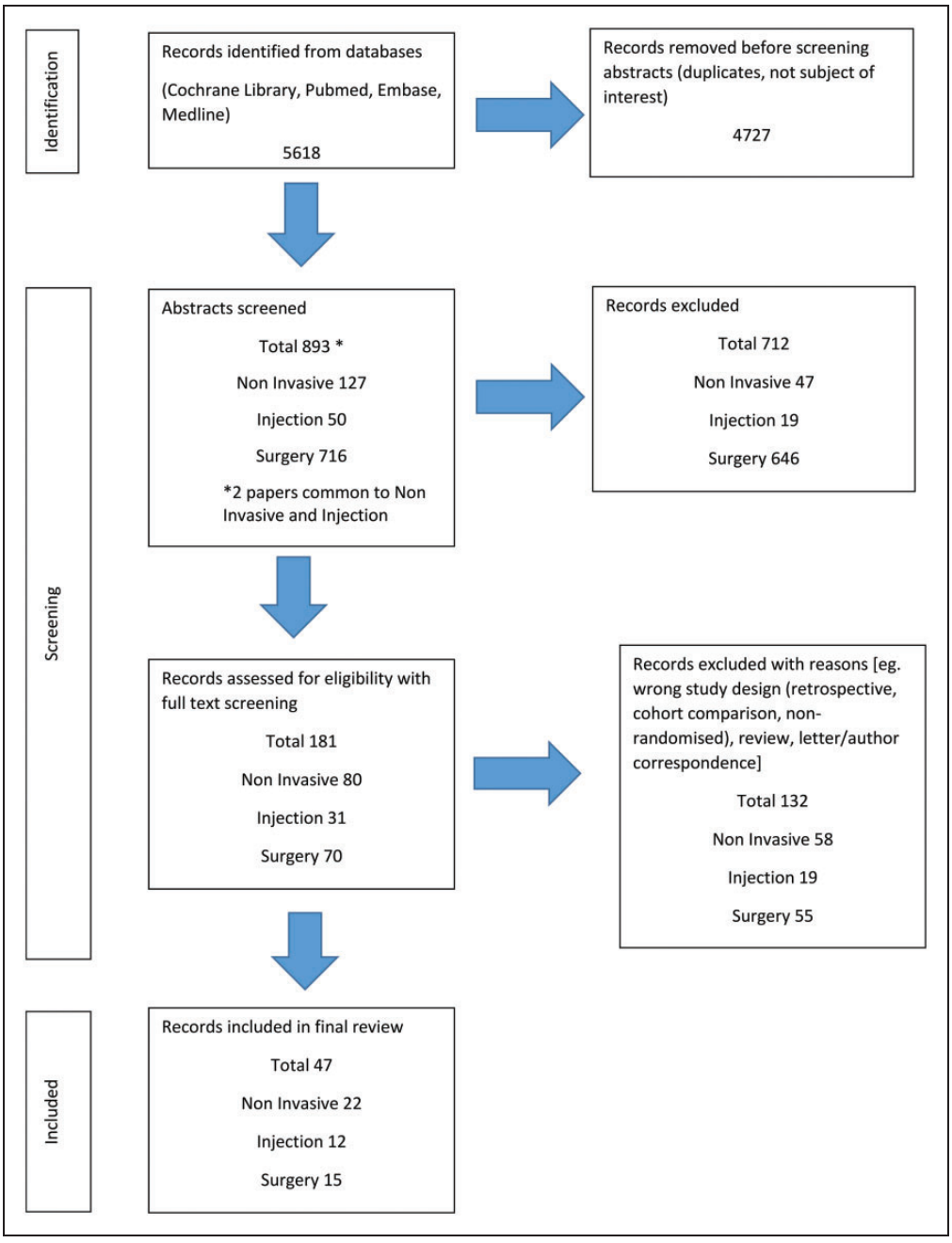

Figure 1. Prisma flowchart for the systematic reviews.

Overall, there is consistency in the available evidence that non-surgical treatment for TBOA provides clinically worthwhile improvements in pain and function.

There is moderate-quality evidence to support exercise over no exercise (Villafane et al., 2013) with large benefits in pain reduction seen in the exercise group. Low-quality evidence suggests there is no difference in outcome when using different types of exercise (Davenport et al., 2012; Wajon and Ada, 2005) and there is no evidence to suggest one type of exercise is superior to another, with a variety of techniques reported in the trials (Bertozzi et al., 2015; Kroon et al., 2018). In conclusion, the current evidence suggests that exercise is beneficial as an active strategy for long-term management but may not be required daily to make gains and three times per week (Adams et al., 2021) may suffice.

Most of the splint studies in this review have either compared different splints or compared splints with usual care. There is low- to moderate-quality evidence to support splinting when compared with usual care. However, no study provides clear criteria

for splint choice, and low- to moderate-quality evidence suggests that when splints are fabricated and fitted by a therapist, specific designs did not make a difference to changes in pain or function (e.g. including the metacarpophalangeal joint or not, wrist based or soft vs. hard) (Buhler et al., 2019; Rannou et al., 2009; Rivlin and Beredjiklian, 2018).

A moderate-quality study (Hermann et al., 2012) found no benefit of a splint and exercise over exercise alone. However, this study did find that splints provide some immediate pain relief when worn for certain tasks. A more recent high-quality placebo-controlled splint study (Adams et al., 2021), found that on average there was no additional benefit of splinting (true or placebo) to an optimal package of self-management. Self-management consists of a multimodal approach that includes education about the condition, exercise, task modification, pacing, forming healthy habits, pain management (including identification of pain triggers) and splinting. Effectiveness of packages of care has also been seen previously in cohort studies. For example, a study describing the role of exercise aimed at restoring the dynamic stability of the trapeziometacarpal joint, in conjunction with education and splints, demonstrated improved pain and function after 6 weeks (O'Brien and Giveans, 2013). Another study demonstrated that greater reductions in pain were achieved when exercises were used in addition to splints (Wouters et al., 2019).

Patient education has only been investigated in a limited number of hand osteoarthritis trials, which included patients with TBOA (Dziedzic et al., 2015; Kjeken et al., 2011). Both trials showed the superiority of therapist delivered education over leaflets. Since completion of the searches for this review a 'high-quality' randomized controlled trial was published, reporting on the efficacy of multimodal intervention (splint, exercise and topical non-steroidal anti-inflammatory drugs, NSAIDs) vs. education alone (Deveza et al., 2021). They demonstrated that education alone provided significant pain relief; however, hand function and mental health were enhanced by the addition of the multimodal therapies. Interestingly by 6 months patients did not tend to continue with all the components (splint and NSAIDs were used by less than 25%, 40–60% continued to use exercise), other than ergonomic adjustments (70%), but they maintained their improvements.

Injections

Seven randomized controlled trials and five systematic reviews were included. The studies investigated the effects of corticosteroid, placebo (normal saline) and hyaluronic acid (HA) injections in TBOA.

Overall, there was low- to moderate-quality evidence that corticosteroid injections were effective in improving pain and function in patients with TBOA. The evidence from three moderate-quality RCTs comparing steroid with placebo (Heyworth et al., 2008; Jahangiri et al., 2014; Meenagh et al., 2004) and five low- (Bahadir et al., 2009; Stahl et al., 2005) to moderate- (Fuchs et al., 2006; Heyworth et al., 2008; Monfort et al., 2015) quality RCTs comparing steroid with HA concurred that pain improved with steroid injections over 2 weeks to 6 months. Hand function assessed using a variety of scoring systems also improved in the short term.

In addition to the individual trials, there were three moderate-quality systematic reviews (Fowler et al., 2015; Kroon et al., 2018; Trellu et al., 2015) and a further high-quality systematic review (Riley et al., 2019) that addressed the use of injections in TBOA. These studies also reported short-term improvements in pain and function following injections but failed to demonstrate superiority of one injectable over another. In summary, when compared with each other, there was moderate-quality evidence suggesting no difference in the pain relief provided by steroids compared with placebo (saline injection) and low- to moderate-quality evidence that both steroids and HA provided similar pain relief. There was no agreement as to which treatment provided more sustained benefit.

It is worth noting that HA is not currently approved by the NICE for intraarticular injection in the treatment of osteoarthritis (NICE guideline NG 226: https://www.nice.org.uk/guidance/ng226). This is based on studies in large joint (hip and knee) osteoarthritis that demonstrate no consistent benefit in terms of pain relief, improved function or quality of life and potential harm (hip osteoarthritis).

Image-guided injections. Within the included studies, there were no comparisons of the landmark technique against image-guided injections. Landmark techniques verified with fluoroscopy found landmark techniques were accurate in 58% (Helm et al., 2003) to 64% (Hunter et al., 2015) of cases. Cadaveric injection of the thumb base with the utilization of blue dye showed that the landmark technique achieves intra-articular injection 50% of the time (To et al., 2017). However, it remains unclear whether image guidance for an accurate injection into the intra-articular space is important in achieving clinical benefit (Cunnington et al., 2010). In a database study comparing the landmark technique with image-guided injections with

ultrasound, there was no difference in the interval between treatment or time to surgery for 62,333 patients with TBOA (Gershkovich et al., 2021). A more recent prospective study (Katt et al., 2022) comparing intra- and extra-articular injections of corticosteroid in 102 thumbs reported equal benefits in the short term with both techniques but better pain relief and functional improvement with intra-articular injections at 3 months, with some maintaining their benefit at 6 months.

Complications after steroid injections are uncommon. Fat necrosis and skin depigmentation are possibilities, but more serious complications are exceedingly rare. A recent review of Hospital Episode Statistics data including over 19,000 steroid injections concluded that the rate of serious complications, namely septic arthritis, neurovascular injury, need for wound debridement or tendon repair after a primary steroid injection in secondary care was 0.04% within 90 days (Lane et al., 2021). The study also reported that half of these patients needed further treatment for their TBOA, with one in five progressing to surgery.

In conclusion, evidence suggests that steroid injections are effective in the short term (1–6 months) and the associated risks are extremely low.

Surgical treatment

The review identified 15 eligible RCTs. Using the SIGN 50 criteria, we assessed five studies (Brennan et al., 2020; Field and Buchanan, 2007; Gangopadhyay et al., 2012; Salem and Davis, 2012; Thorkildsen and Røkkum, 2019) as moderate quality while the remaining studies had greater risk of bias and were assessed as low quality (Belcher and Nicholl 2000; Corain et al., 2016; Smet et al., 2004; Gerwin et al., 1997; Hart et al., 2006; Kriegs-Au et al., 2004; Marks et al., 2017; Nilsson et al., 2010; Tagil and Kopylov, 2002; Vermeulen et al., 2014).

A high-quality systematic review (Wajon et al., 2015) included 11 studies comparing different types of surgery. Pain improved post operatively without differences between groups. The authors were unable to find conclusive evidence that one technique conferred a benefit over another for pain relief and physical function. They commented that the available studies were of insufficient quality to provide conclusive evidence.

The current review includes an additional four studies published since that met our inclusion criteria. We agree with Wajon et al. (2015) that the overall quality of the published studies is low to moderate.

Trapeziectomy is the most commonly performed surgical procedure that was compared with other procedures. Most studies compared trapeziectomy with various forms of ligament reconstruction and tendon interposition (LRTI) (Belcher and Nicholl 2000; Brennan et al., 2020; Smet et al., 2004; Field and Buchanan, 2007; Gangopadhyay et al., 2012; Salem and Davis, 2012) or trapeziectomy with soft tissue interposition without ligament reconstruction (Corain et al., 2016; Gangopadhyay et al., 2012). Others compared trapeziectomy and LRTI with trapeziectomy and ligament reconstruction alone (Gerwin et al., 1997; Kriegs-Au et al., 2004) or soft tissue interposition alone (Gangopadhyay et al., 2012). Few additional studies compared trapeziectomy and LRTI with implant arthroplasty (Tagil and Kopylov, 2002; Thorkildsen and Røkkum, 2019) or arthrodesis (Hart et al., 2006; Vermeulen et al., 2014).

Based on our review and considering the overall low quality of the available evidence, we were unable to find any one surgical procedure that was better than another for providing pain relief or improving function. Trapeziectomy with LRTI was most often compared with other procedures. When compared with trapeziectomy alone, we found low to moderate evidence that LRTI does not provide any additional benefit to trapeziectomy.

Pain was reported using different methods in the included studies. All studies consistently reported good to excellent pain relief. Studies using the visual analogue Scale (VAS) reported residual pain levels of 20–30 on a 100-point scale, while others reported that 80% had no or mild pain at final follow-up. When compared with pre-operative values, the improvement was significant but not all studies reported a comparison with pre-operative values. Overall, there is low-quality evidence that suggests no difference in the pain relief provided by the various operations being compared. Wajon et al. (2015) conducted an analysis of pooled data for pain relief using the VAS scale comparing trapeziectomy with trapeziectomy and LRTI (Belcher and Nicholl 2000; Smet et al., 2004; Field and Buchanan, 2007). They reported that the pain relief provided by trapeziectomy and LRTI was 3 mm lower on a 0–100 VAS scale compared with trapeziectomy alone. They also concluded that there was low-quality evidence that trapeziectomy and LRTI did not provide any additional benefit to pain relief when compared to trapeziectomy alone.

Physical function was also reported using different methods in the included studies. When compared with pre-operative values, this improvement was significant but not all studies reported a comparison with pre-operative values. Overall, there is low-quality evidence that suggests no difference in the improvement in physical function between the

various operations. Wajon et al. (2015) also conducted an analysis of pooled data for physical function using the DASH score comparing trapeziectomy with trapeziectomy + LRTI (Belcher and Nicholl 2000; Smet et al., 2004; Salem and Davis, 2012). They reported that DASH for trapeziectomy + LRTI was 0.03 points higher on a 0–100-point scale compared with trapeziectomy alone. They concluded that there was low-quality evidence that trapeziectomy + LRTI did not provide any additional benefit to physical function when compared with trapeziectomy alone.

Most of the included studies reported complications following surgery. Individual studies comparing trapeziectomy, trapeziectomy with LRTI and trapeziectomy with soft tissue interposition did not report any difference in adverse events between the procedures compared. Two studies comparing trapeziectomy and LRTI with arthrodesis (Hart et al., 2006; Vermeulen et al., 2014) reported increased complications with arthrodesis, resulting in the study being stopped in the latter. Studies comparing trapeziectomy and LRTI with implant arthroplasty (Tagil and Kopylov, 2002; Thorkildsen and Røkkum, 2019) have reported increased complications with the latter. However, the reporting of complications in these studies is of sufficiently low quality such that conclusions about adverse events cannot be drawn from them.

A recent systematic review and network metanalysis of randomised controlled trials comparing surgical interventions for TBOA (Challoumas et al., 2022) reached the same conclusion as our review, stating that there was evidence of moderate certainty that trapeziectomy with LRTI did not appear to be associated with any long-term benefits when compared with trapeziectomy alone. The authors also concluded that there was some increase in the frequency of minor complications with LRTI compared with trapeziectomy alone, while arthrodesis and joint replacement arthroplasty had the highest incidence of major complications. They recommended that trapeziectomy alone should be the preferred surgical treatment for TBOA until further high-quality evidence was available to suggest otherwise.

Implant arthroplasty. Recently, there has been increased interest in implant arthroplasty owing to reports of rapid rehabilitation and improved pain and function, together with longer implant survival with the more recent uncemented prosthetic designs (Chiche et al., 2022; Hansen, 2021; Martin-Ferrero, 2014; Toffoli and Teissier, 2017), particularly the dual-mobility prosthesis (Falkner et al., 2023; Lussiez et al., 2021). As a result of these encouraging results, implant arthroplasty is gaining an increasing role in selected patients. A recent randomized controlled trial published after the completion of this review, comparing trapeziectomy with a single-mobility implant arthroplasty (de Jong et al., 2023), found no significant difference in the functional outcomes between the two procedures at 12 months, although the range of movement and strength were better in the implant group. However, more high-quality Level 1 studies with greater numbers of patients and longer follow-up are required to provide guidance on the use of implant arthroplasty going forward. The National Institute of Health and Care Research has recently approved a multi-centre randomised controlled trial (Surgery versus Conservative Osteoarthritis of Thumb Trial) to determine the clinical and cost effectiveness of treating TBOA, with or without surgery, and to determine the clinical and cost effectiveness of trapeziectomy vs. base of thumb joint replacement. The results of this or similar trials, when available, will help further guide surgical and non-surgical treatment of TBOA in the future. At present, there appears to be insufficient evidence to recommend joint replacement arthroplasty over trapeziectomy as the primary surgical treatment of TBOA, at least in the longer term.

Evidence based guidelines

The evidence synthesised from the systematic reviews are presented as *Key clinical practice recommendations*, with an indication of the strength of evidence for each recommendation.

Key clinical practice recommendations

- The treatment of thumb base osteoarthritis should follow a step-wise approach, starting with non-surgical measures with low risk of harm before progressing to more invasive and complex treatments if pain and dysfunction continue. We were unable to find evidence to support the suggested sequence of treatment, but the group and most clinicians agree that the treatment of TBOA should follow a treatment escalation ladder.
- We recommend that non-surgical treatment should be offered to all patients presenting with symptomatic TBOA (high evidence). Non-invasive treatment consists of a comprehensive package of self-management. A comprehensive self-management programme consists of a multimodal therapy approach that includes the following components: education about the condition; exercise; task modification; pacing; forming healthy habits; and pain management (including identification of pain triggers). Patients should

understand the principles of self-management as a priority and actively engage in self-management strategies.
- Splints should be considered as an option in the treatment ladder for those who have not responded to a self-management package of treatment (low to moderate evidence). This may be particularly important for those who are unable to engage actively in their treatment, or who have restrictions in their ability to modify aggravating tasks.
- Intra-articular corticosteroid injection is a low-risk procedure (high evidence) that provides short-term pain relief (low to moderate evidence) and should be considered in those who have not responded to a comprehensive self-management programme ± splint.
- If symptoms fail to resolve with self-management ± splint ± steroid injection, surgery should be considered in patients with TBOA (moderate evidence). When surgery is indicated, consider excision of the trapezium alone, as additional procedures such as interposition and ligament reconstruction do not appear to confer any benefit over trapeziectomy on its own (low evidence).

Good practice points

Figure 2 is a Quick Reference Guide containing a one-page summary of the guidelines which can be used for display and use by clinicians in clinical areas. Figure 3 contains a detailed pathway for the patient's journey from first presentation in primary care to discharge, incorporating the key recommendations and good practice points.

In addition, the following guidance is included to further refine and provide practical advice towards implementing the recommendations. It is considered good practice that:

- Healthcare professionals should support the patients in a self-management programme to optimise outcome. They should direct the patients to high quality resources and educational material. Although multiple sources of information exist (see Figures 2 and 3), the group found the information provided by the Osteoarthritis Thumb Therapy II trial to be one of the most comprehensively developed sources of publicly available educational material. The information was developed involving patients and research with clinicians and can be found in the published study protocol (Adams et al., 2019).
- Where facilities exist, referral to the local hand therapy service or musculo-skeletal service with hand therapy expertise should be considered. To improve outcome, it is recommended that self-management should be individualised to patients to ensure the relevance of the information and treatment, for example, exercises tailored to address specific deficiencies and task modification tailored to the aggravating activities. Psychologically informed delivery may be important in optimizing patient engagement, e.g. goal setting, identifying barriers and facilitators to engagement, assessing confidence and signing contracts (Adams et al., 2021).
- In the absence of clear evidence regarding choice and wearing schedule for splints, where these are indicated they should be prescribed to fit to a person's lifestyle and requirements (activities of daily living, job, hobbies) to ensure compliance and improve outcome. Splints should not be the first and only non-invasive treatment prescribed.
- Steroid injections are known to provide short-term pain relief (commonly 3 months and up to 6 months). The cost-effectiveness of repeated injections is unclear but the group consider it reasonable to repeat injections if the patient does not wish to have surgery and the benefit has lasted for 6 months or more.
- Image guidance improves the accuracy of injections and may provide longer pain relief but currently there is no evidence to support the use of imaging over the landmark technique in the outpatient setting.
- Surgery should only be offered after a reasonable trial of non-surgical management. The group consider it reasonable to offer surgery if symptoms fail to resolve after 6 months of non-surgical management consisting of supported self-management ± splint ± corticosteroid injection(s).
- Patients treated with surgery should be added to the local hand registry where it exists to allow assessment and analyses of outcomes.

Clinical audit indicators and future research recommendations

The following could be used as clinical audit indicators to evaluate practice and align services with the recommendations of the guidelines.

- provision of pre-hospital supported self-management before referral to secondary care;
- rate of steroid injections after supported self-management;
- rate of conversion to surgery following supported self-management;

Quick Reference Guide

- Non-invasive treatment should be offered to all patients presenting with symptomatic thumb base osteoarthritis (TBOA). This consists of a multimodal comprehensive package of self-management.
- Healthcare professionals should support the self-management programme by directing the patients to high quality resources and educational materials* listed below. Where facilities exist, referral to the local hand therapy service or MSK service with hand therapy expertise should be considered.
- Splints should be considered for those who have not responded to a self-management package.
- Intra-articular corticosteroid injection should be considered in those who have not responded to a self-management programme +/- splint. This can be performed in the out-patient setting using landmark technique.
- If symptoms fail to resolve with the above treatment, surgery should be considered in patients with TBOA. When surgery is indicated, consider trapeziectomy alone.

Resources and Educational Materials to support self-management*

Pulvertaft Hand Centre *(https://pulvertafthandcentre.org.uk/patient-information/)*

Basal thumb arthritis | The British Society for Surgery of the Hand *(https://www.bssh.ac.uk/patients/conditions/24/basal_thumb_arthritis)*

https://www.versusarthritis.org/about-arthritis/conditions/hand-and-wrist-pain/

The Osteoarthritis Thumb Therapy (OTTER) II Trial: a study protocol (Adams J, et al. BMJ Open 2019; 9:e028342. doi: 10.1136/bmjopen-2018-028342)

EULAR HPR Guide for Hand Osteoarthritis (*https://esor.eular.org/course/view.php?id=130ngi)*

*Hyperlinks to resources on *https://www.bssh.ac.uk/professionals/best_guidelines.aspx*

Figure 2. Quick reference guide: a one-page summary of the guidelines for display and use in clinical areas.

- submission of data to the UK Hand Registry for all surgical procedures.

The main research recommendations are summarized in Table 1. High-quality RCTs on the effectiveness of a well-executed comprehensive self-management programme and the medium- to long-term outcomes of modern implant arthroplasty techniques would have maximum impact on the management of TBOA going forward. Future studies

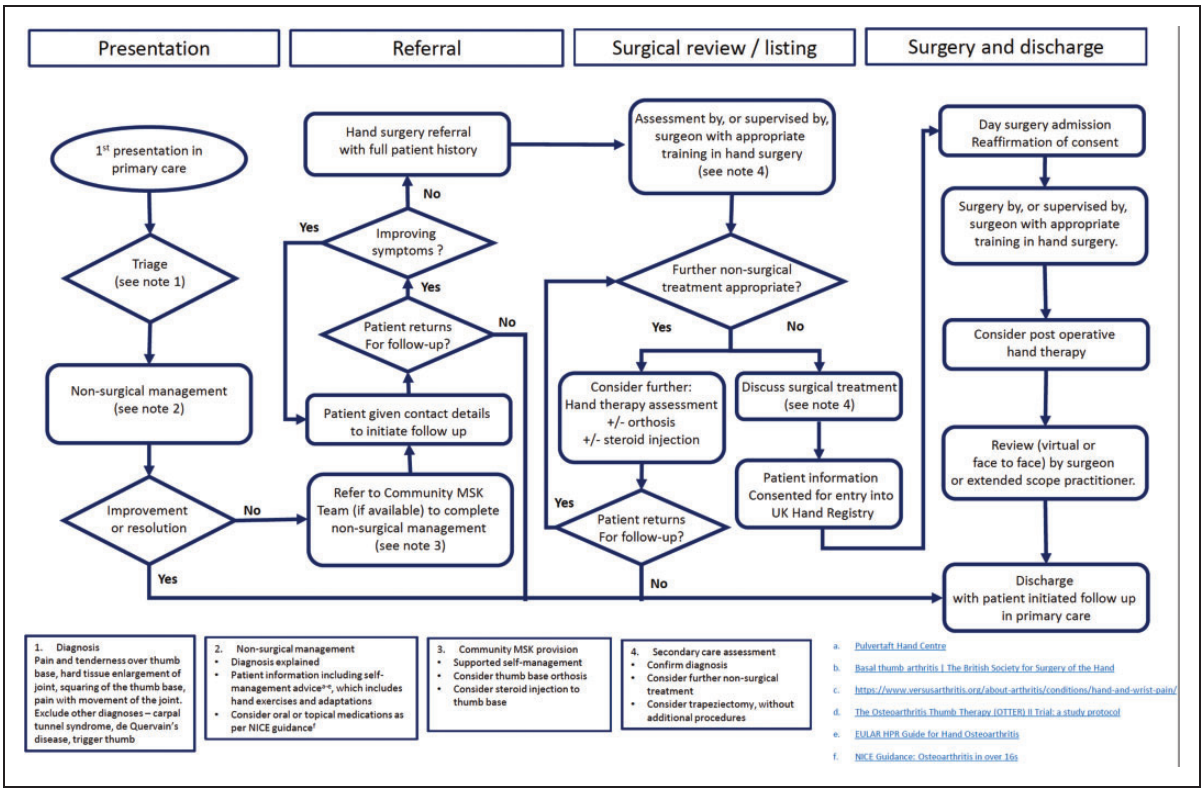

Figure 3. Patient flow algorithm: a detailed pathway for the patient's journey from first presentation in primary care to discharge, incorporating the key recommendations and good practice points. Resources are available on the full version at www.bssh.ac.uk/professionals/best_guidelines.aspx and Supplementary material 1: British Society for Surgery of the Hand Evidence for Surgical Treatment (BEST).

Table 1. Areas for future research into the management of thumb base osteoarthritis.

Suggested studies
1. Is night splinting and supported self-management more effective at reducing pain compared with supported self-management alone?
2. What are the long-term outcomes of conservative management (supported self-management, including splints and steroid injections) of thumb base osteoarthritis?
3. Does early intervention with supported self-management and task modification alter disease course?
4. Is an accurate joint injection with image guidance necessary for symptom relief?
5. What is the clinical and cost-effectiveness of repeated corticosteroid injections?
6. Is it possible to identify the need for surgery (threshold) based on a functional or objective scoring system?
7. Surgery vs. non-surgical treatment (supported self-management) – long term outcomes.
8. Trapeziectomy vs. implant arthroplasty using newer generation, e.g. dual mobility implants.

should be designed using validated and standardised outcome measures to allow meaningful interpretation and comparison of results.

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Informed consent Not applicable.

Ethical approval Not applicable.

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