AAOS
American Academy of Orthopaedic Surgeons

Management of Carpal Tunnel Syndrome

Evidence-Based Clinical Practice Guideline

Adopted by:
The American Academy of Orthopaedic Surgeons Board of Directors
05/18/2024

Endorsed by:

AAHS
American Association for Hand Surgery

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Disclaimer

This clinical practice guideline (CPG) was developed by a physician/clinician volunteer clinical practice guideline development group based on a formal systematic review of the available scientific and clinical information and accepted approaches to treatment and/or diagnosis. This clinical practice guideline is not intended to be a fixed protocol, as some patients may require more or less treatment or different means of diagnosis. Clinical patients may not necessarily be the same as those found in a clinical trial. Patient care and treatment should always be based on a clinician's independent medical judgment, given the individual patient's specific clinical circumstances.

Disclosure Requirement

In accordance with AAOS policy, all individuals whose names appear as authors or contributors to the clinical practice guideline filed a disclosure statement as part of the submission process. All panel members provided full disclosure of potential conflicts of interest prior to voting on the recommendations contained within this clinical practice guideline.

Funding Source

This clinical practice guideline was funded exclusively by the American Academy of Orthopaedic Surgeons who received no funding from outside commercial sources to support the development of this document.

FDA Clearance

Some drugs or medical devices referenced or described in this clinical practice guideline may not have been cleared by the Food and Drug Administration (FDA) or may have been cleared for a specific use only. The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or device he or she wishes to use in clinical practice.

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First Edition

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SUMMARY OF RECOMMENDATIONS

Recommendations are formed when there is sufficient evidence by which to create a directional statement. This is defined as evidence from two or more high quality studies (i.e., a strong recommendation), two or more moderate quality studies (i.e., a moderate recommendation), or statements resulting in a strong or moderate strength following Evidence to Decision Framework upgrading and/or downgrading.

DIAGNOSIS: CTS-6, ULTRASONOGRAPHY, NCV/EMG

Strong evidence suggests that CTS-6 can be used to diagnose carpal tunnel syndrome, in lieu of routine use of Ultrasonography or NCV/EMG.

Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

DIAGNOSIS: MRI, UPPER LIMB NEURODYNAMIC TESTING

Moderate evidence suggests that MRI and Upper Limb Neurodynamic Testing should not be used to diagnose carpal tunnel syndrome.

Quality of Evidence: Moderate

Strength of Recommendation: Moderate ★★★☆

Evidence from two or more "Moderate" quality studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. Also requires no or only minor concerns addressed in the EtD framework.

CORTICOSTEROID INJECTION

Strong evidence suggests corticosteroid injection does not provide long-term improvement of carpal tunnel syndrome.

Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

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Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

PLATELET-RICH PLASMA (PRP) INJECTION

Strong evidence suggests PRP Injection does not provide long-term benefits in non-operative treatment of carpal tunnel syndrome (leukocyte rich or leukocyte poor PRP).

Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

SURGICAL RELEASE TECHNIQUE

Strong evidence suggests that there is no difference in patient reported outcomes between a mini-open carpal tunnel release and an endoscopic carpal tunnel release.

Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

MODES OF ANESTHESIA

Strong evidence suggests local anesthesia alone can be used for carpal tunnel release.

Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

POSTOPERATIVE THERAPY

Moderate evidence suggests postoperative supervised therapy should not be routinely prescribed after carpal tunnel release.

Quality of Evidence: Moderate

Strength of Recommendation: Moderate 

Evidence from two or more "Moderate" quality studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. Also requires no or only minor concerns addressed in the EtD framework.

POSTOPERATIVE IMMOBILIZATION

Moderate evidence suggests immobilization through sling or orthosis (e.g., splint, brace) should not be used after carpal tunnel release.

Quality of Evidence: Moderate

Strength of Recommendation: Moderate 

Evidence from two or more "Moderate" quality studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. Also requires no or only minor concerns addressed in the EtD framework.

POSTOPERATIVE PAIN: NSAID, ACETAMINOPHEN

Strong evidence suggests that NSAIDs and/or Acetaminophen should be used after carpal tunnel release for postoperative pain management.

Quality of Evidence: High

Strength of Recommendation: Strong 

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

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SUMMARY OF OPTIONS

Options are formed when there is little or no evidence on a topic. This is defined as low quality evidence or a single moderate quality study (i.e., a limited strength option), no evidence or only conflicting evidence (i.e., a consensus option), or statements resulting in a limited or consensus strength following Evidence to Decision Framework upgrading and/or downgrading.

RISK FACTORS: KEYBOARDING, CLERICAL WORK

In the absence of reliable evidence, it is the opinion of the workgroup that there is no association between high keyboard use and carpal tunnel syndrome.

Quality of Evidence: Very Low
Strength of Option: Consensus ★☆☆☆
There is no supporting evidence, or limited level evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.

THERAPEUTIC ULTRASOUND

Evidence suggests therapeutic ultrasound does not provide long-term improvement of carpal tunnel syndrome.

Quality of Evidence: High
Strength of Option: Limited ★★☆☆ (Downgraded)
Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Option was downgraded based on EtD framework.

NON-OPERATIVE TREATMENTS VS. PLACEBO/CONTROL

Evidence suggests that the following non-operative treatments do not demonstrate superiority over control or placebo: acupressure, insulin injection, heat therapy, magnet therapy, nutritional supplementation, oral diuretic, oral NSAID, oral anticonvulsant, phonophoresis.

Quality of Evidence: High
Strength of Option: Limited ★★☆☆ (Downgraded)
Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Option was downgraded based on EtD framework.

NON-OPERATIVE TREATMENTS: LONG-TERM

Evidence suggests the following non-operative treatments do not improve long-term patient reported outcomes for carpal tunnel syndrome: oral corticosteroid, hyaluronic acid injection, hydro dissection, kinesiotaping, laser therapy, peloid therapy, perineural injection therapy, topical treatment, shockwave therapy, exercise, ozone injection, massage therapy, manual therapy, pulsed radiofrequency.

Quality of Evidence: High

Strength of Option: Limited ★★☆☆ (Downgraded)

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Option was downgraded based on EtD framework.

COMPARISON OF NON-OPERATIVE TREATMENTS

Evidence suggests no significant difference in patient reported outcomes between non operative treatment techniques for carpal tunnel syndrome.

Quality of Evidence: High

Strength of Option: Limited ★★☆☆ (Downgraded)

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Option was downgraded based on EtD framework.

SITE OF SERVICE

Limited evidence suggests carpal tunnel release may be safely conducted in the office setting.

Quality of Evidence: Low

Strength of Option: Limited ★★☆☆

Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for or against the intervention. Also, higher strength evidence can be downgraded to limited due to major concerns addressed in the EtD Framework.

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SURGICAL DRAPING

In the absence of reliable evidence, it is the opinion of the workgroup that limited draping is an option for carpal tunnel release.

Quality of Evidence: Consensus
Strength of Option: Consensus ★☆☆☆
There is no supporting evidence, or limited level evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.

ANTICOAGULATION

Limited evidence suggests anticoagulation medication may be safely continued for carpal tunnel release.

Quality of Evidence: Low
Strength of Option: Limited ★★☆☆
Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for or against the intervention. Also, higher strength evidence can be downgraded to limited due to major concerns addressed in the EtD Framework.

PROPHYLACTIC PERIOPERATIVE ANTIBIOTICS

Limited evidence suggests perioperative prophylactic antibiotics are not indicated for the prevention of surgical site infection following carpal tunnel release.

Quality of Evidence: Low
Strength of Option: Limited ★★☆☆
Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for or against the intervention. Also, higher strength evidence can be downgraded to limited due to major concerns addressed in the EtD Framework.

PREOPERATIVE TESTING

In the absence of sufficient evidence specific to carpal tunnel, it is the opinion of the workgroup that routine pre-operative testing (e.g., labs, CXR, EKG) is not indicated.

Quality of Evidence: Very Low
Strength of Option: Consensus ★☆☆☆
There is no supporting evidence, or limited level evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.

ADJUNCTIVE TESTING

In the absence of reliable evidence, it is the opinion of the workgroup that, when multiple risk factors for amyloidosis are present, pathological analysis of tenosynovium may be performed.

Quality of Evidence: Consensus
Strength of Option: Consensus ★☆☆☆
There is no supporting evidence, or limited level evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.

POSTOPERATIVE PAIN: TRAMADOL

In the absence of reliable evidence, it is the opinion of the workgroup that Tramadol may be considered over other opioids for postoperative pain management.

Quality of Evidence: Very Low
Strength of Option: Consensus ★☆☆☆
There is no supporting evidence, or limited level evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.

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DEVELOPMENT GROUP ROSTER

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INTRODUCTION

OVERVIEW

This clinical practice guideline is based on a systematic review of published studies with regard to the diagnosis and treatment of carpal tunnel syndrome (CTS). It provides recommendations that will help practitioners to integrate the current evidence and clinical practice, and it highlights gaps in the literature in need of future research. This guideline is intended to be used by appropriately trained physicians and clinicians involved in the diagnosis and treatment of carpal tunnel syndrome. It also serves as an information resource for developers and applied users of clinical practice guidelines.

GOALS AND RATIONALE

The purpose of this clinical practice guideline is to evaluate the current best evidence associated with treatment. Evidence-based medicine (EBM) standards advocate for use of empirical evidence by physicians in their clinical decision making. To assist with access to the large resources of information, a systematic review of the literature in publication was conducted between March 2022 and August 2023. It highlights where there is good evidence, where evidence is lacking, and what topics future research will need to target in order to help facilitate evidence-based decision making in the diagnosis and treatment of patients with carpal tunnel syndrome. AAOS staff methodologists assisted the physician/clinician work group in evaluating the existing literature so that they could formulate the following recommendations based on a rigorous systematic process. Musculoskeletal care is provided in many different settings and by a variety of providers. We created this guideline as an educational tool to guide qualified physicians and clinicians in making treatment decisions that improve the quality and efficacy of care. This guideline should not be construed as including all possible methods of care or excluding acceptable interventions similarly directed at obtaining favorable outcomes. The final decision to use a specific procedure must be made after assessing all concerns presented by the patient and consideration of locality-specific resources.

INTENDED USERS

This guideline is intended to be used by orthopaedic surgeons and other healthcare providers managing carpal tunnel syndrome. It serves as an information resource for medical practitioners. In general, individual practicing physicians and clinicians do not have the resources required to complete a project of comparable scope and duration involving the evaluation of an extensive literature base. In April 2019, the AAOS adopted the use of the GRADE Evidence-to-Decision Framework into its clinical practice guideline development methodology. This Framework enables work group members to incorporate additional factors into the strength of each recommendation and move away from the rigidity of previous AAOS recommendation language stems. The AAOS intends for this guideline to assist treatment providers not only in making shared clinical decisions with their patients, but also in describing to patients and their loved ones why a selected intervention represents the best available course of treatment. This guideline is not intended for use as a benefits determination document. It does not cover allocation of resources, business and ethical considerations, and other factors needed to determine the material value of orthopaedic care. Users of this guideline may also want to consider the appropriate use criteria (AUC) related to the management of carpal tunnel syndrome.

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PATIENT POPULATION

This guideline addresses the diagnosis and treatment of adult patients (≥ 18 years of age) presenting with complaints which may be attributable to carpal tunnel syndrome.

SCOPE

The scope of this guideline includes the diagnosis and treatment of carpal tunnel syndrome.

ETIOLOGY

CTS is caused by compression of the median nerve under the transverse carpal ligament. Although compression/pressure on the median nerve is the pathophysiologic basis for the observed symptoms, the etiology of elevated pressure within the carpal canal is unknown.

INCIDENCE AND PREVALENCE

CTS has an annual crude incidence of 329 cases per 100,000 person-years (Mondelli 2002). The prevalence of CTS in the general adult population ranges from 2.7-4.9%. (Atroshi 1999).

BURDEN OF DISEASE

CTS is the most common compressive neuropathy affecting the upper extremity and is an important cause of morbidity and lost productivity. In the Medicare patient population alone, the disease burden of CTS accounts for $2.7 to $4.8 billion USD annually. (Hubbard 2018) In the US, the median lost worktime from carpal tunnel syndrome is 28 days, second only to fractures. (US Bureau of Labor and Statistics 2015).

EMOTIONAL AND PHYSICAL IMPACT

The principal impact of CTS on patients relates to the sensory disturbance which may disrupt sleep and, during non-sleeping hours, impair strength and dexterity. CTS may also be associated with pain in the wrist and digits. These symptoms may have a substantial effect on an individual's ability to accomplish activities of daily living and to perform work-related duties.

POTENTIAL BENEFITS, HARM, AND CONTRAINDICATIONS

The main benefits of these guidelines include streamlining and standardizing the work up and treatment for CTS based upon the best available evidence. This may have important impact on the work up and treatment of CTS, for example by minimizing the risk of incorrect diagnosis and minimizing unnecessary care in the pre-operative (pre-operative testing), intra-operative (antibiotic use), and post-operative (immobilization) phases of surgical care. Many tests and treatments are associated with some known risks. Factors that may impact a treating clinician's recommendations include but are not limited to pre-test probability for CTS, a patient's comorbidities, etc. Further, an individual patient and their caregiver network impact treatment decisions and thus a discussion of available options as well as the risks and benefits applicable to the individual patient in the context of their values, preferences, and goals should be guided by a shared decision-making process. After a patient and/or their caregiver network have been informed of available options and have discussed each option with their clinician, an informed decision can be made.

DIFFERENCES BETWEEN THE PRESENT AND PREVIOUS GUIDELINES

This updated clinical practice guideline replaces the first edition that was completed in 2016, "Management of Carpal Tunnel Syndrome." This update considered the literature that we previously examined as well as the empirical evidence published since the 2016 guideline. In April 2019, the AAOS adopted the use of the GRADE Evidence-to-Decision Framework into its clinical practice guideline development methodology. This Framework enables work group members to incorporate additional factors into the strength of each recommendation and move away from the

rigidity of previous AAOS recommendation language stems. The complete listing of inclusion criteria for this guideline is detailed in the section, "Inclusion Criteria," (Appendix II). A notable change to this updated guideline is the focus on the long-term effect of CTS treatment options. The 2016 guideline made several recommendations regarding the short-term effects of CTS treatments which are not present in the 2024 guideline, as the CPG development work group set out to evaluate the long-term, disease-modifying benefits of various treatment options.

METHODS

The methods used to perform this systematic review were employed to minimize bias and enhance transparency in the selection, appraisal, and analysis of the available evidence. These processes are vital to the development of reliable, transparent, and accurate clinical recommendations. To view the full AAOS clinical practice guideline methodology please visit https://www.aaos.org/quality/research-resources/methodology/.

This clinical practice guideline evaluates the management of carpal tunnel syndrome. The AAOS approach incorporates practicing physicians (clinical experts) and methodologists who are free of potential conflicts of interest relevant to the topic under study, as recommended by clinical practice guideline development experts.[1]

This clinical practice guideline was prepared by the AAOS Carpal Tunnel Syndrome Guideline physician development group (clinical experts) with the assistance of the AAOS Clinical Quality and Value (CQV) Department (methodologists). To develop this clinical practice guideline, the clinical practice guideline development group held an introductory meeting on March 6th, 2022, to establish the scope of the clinical practice guideline. As the physician experts, the clinical practice guideline development group defined the scope of the clinical practice guideline by creating PICO Questions (i.e., population, intervention, comparison, and outcome) that directed the literature search. The AAOS Medical Librarian created and executed the search (see Appendix III for search strategy).

LITERATURE SEARCHES

The systematic review begins with a comprehensive search of the literature. Articles considered were published prior to the start date of the search in a minimum of three electronic databases; PubMed, EMBASE, and the Cochrane Central Register of Controlled Trials. The medical librarian conducts the search using key terms determined from the guideline development group's PICO questions.

A CQV methodologist will review/include only primary literature but will supplement the electronic search with a manual search of the bibliographies of secondary literature sources, such as systematic reviews, as available. The methodologist will then evaluate all recalled articles for possible inclusion based on the study selection criteria and will summarize the evidence for the guideline work group who assist with reconciling possible errors and omissions.

A study attrition diagram is provided in the Methods section of each document that details the numbers of identified abstracts, recalled and selected studies, and excluded studies that were evaluated in the CPG. The search strategies used to identify the abstracts are also included in the Appendix of each CPG document.

DEFINING THE QUALITY OF EVIDENCE

The quality of evidence for a recommendation is determined by the quality and quantity of included literature for the statement. Statements with evidence from two or more "High" quality studies are considered to have "High Quality Evidence". Statements with

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evidence from two or more “Moderate” quality studies, or evidence from a single “High” quality study are considered to have “Moderate Quality Evidence”. Statements with evidence from two or more “Low” quality studies or evidence from a single “Moderate” quality study are considered to have “Low Quality Evidence”. Statements with evidence from one “Low” quality study or no supporting evidence are considered to have “Very Low Quality Evidence” or “Consensus” respectively.

DEFINING THE STRENGTH OF RECOMMENDATION

Judging the quality of evidence is only a steppingstone towards arriving at the strength of a CPG recommendation. The strength of recommendation also takes into account the quality, quantity, and the trade-off between the benefits and harms of a treatment, the magnitude of a treatment’s effect, and whether data exists on critical outcomes.

Strength of recommendation expresses the degree of confidence one can have in a recommendation. As such, the strength expresses how possible it is that a recommendation will be overturned by future evidence. It is very difficult for future evidence to overturn a recommendation that is based on many high quality randomized controlled trials that show a large effect. It is much more likely that future evidence will overturn recommendations derived from a few small retrospective comparative studies. Consequently, recommendations based on the former kind of evidence are given a “strong” strength of recommendation and statement based on the latter kind of evidence are presented as options to the practicing clinician, rather than a directional recommendation, with either a “limited” strength or, in the event of no supporting or only conflicting evidence, a “consensus” strength.

VOTING ON THE RECOMMENDATIONS

The recommendations and their strength were voted on by the guideline development group members during the final meeting. If disagreement between the guideline development group occurred, there was further discussion to see whether the disagreement(s) could be resolved. Recommendations were approved and adopted in instances where a simple majority (60%) of the guideline development group voted to approve; however, the guideline development group had consensus (100% approval) when voting on every recommendation for this guideline. Any recommendation strength upgrade or downgrade based on the Evidence-to-Decision Framework requires a super majority (75%) approval of the work group.

UNDERSTANDING THE QUALITY OF EVIDENCE AND STRENGTH OF RECOMMENDATION OR OPTION Statement

Table I. Strength and Quality Descriptions

Statement Strength	Evidence Quality	Statement Description	Strength Visual
Strong	High*	Evidence from two or more "High" quality studies with consistent findings recommending for or against the intervention. Or Rec is upgraded using the EtD framework.	
Moderate	Moderate*	Evidence from two or more "Moderate" quality studies with consistent findings or evidence from a single "High" quality study recommending for or against the intervention. Or Rec is upgraded or downgraded using the EtD framework.	
Limited	Low*	Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for or against the intervention. Or Rec is downgraded using the EtD framework.	
Consensus*	Very Low, or Consensus*	Evidence from one "Low" quality study, no supporting evidence, or Rec is downgraded using the EtD framework. In the absence of sufficient evidence, the guideline work group is making a statement based on their clinical opinion.	

*Unless statement was upgraded or downgraded in strength, using the EtD Framework

Table II. Interpreting the Strength of a Recommendation or Option

Strength of Recommendation	Patient Counseling (Time)	Decision Aids	Impact of Future Research
Strong	Least	Least Important, unless the evidence supports no difference between two alternative interventions	Not likely to change
Moderate	Less	Less Important	Less likely to change
Limited	More	Important	Change possible/anticipated
Consensus	Most	Most Important	Impact unknown

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REVIEW PERIOD

Following the final meeting, the CPG draft undergoes a 3-week review period for additional input from external content experts. Written comments are provided on the structured review form. All reviewers are required to disclose their conflicts of interest.

Specialty societies relevant to the topic are solicited for nominations of individual reviewers approximately six weeks before the final meeting. The review period is announced as it approaches, and others interested are able to volunteer to review the draft. The chairs of the guideline work group review the draft of the guideline prior to dissemination.

Some specialty societies (both orthopaedic and non-orthopaedic) ask their evidence-based practice (EBP) committee to provide review of the guideline. The organization is responsible for coordinating the distribution of our materials and consolidating their comments onto one form. The chair of the external EBP committees provides disclosure of their conflicts of interest (COI) and manages the potential conflicts of their members.

Again, the AAOS asks for comments to be assembled into a single response form by the specialty society and for the individual submitting the review to provide disclosure of potentially conflicting interests. The review stage gives external stakeholders an opportunity to provide evidence-based direction for modifications that they believe have been overlooked. Since the draft is subject to revisions until its approval by the AAOS Board of Directors as the final step in the guideline development process, confidentiality of all working drafts is essential.

The CPG is also provided to members of the AAOS Board of Directors (BOD), members of the Research and Quality Council (RQC), members of the Board of Councilors (BOC), and members of the Board of Specialty Societies (BOS) and members of the Committee on Evidence-Based Quality and Value (EBQV) for review and comment. The CPG is automatically forwarded to the AAOS BOD, RQC, and EBQV so that they may review it and provide comments prior to being asked to approve the document. Based on these bodies, over 200 commentators have the opportunity to provide input into each CPG.

The chairs of the guideline work group, the manager of the AAOS CQV unit, and the Director of AAOS CQV draft the initial responses to comments that address methodology. These responses are then reviewed by the chair and co-chair, who respond to questions concerning clinical practice and techniques. All comments received and the initial drafts of the responses are also reviewed by all members of the guideline development group. All proposed changes to recommendation language as a result of the review period are based on the available evidence that met inclusion criteria. Final revisions are summarized in a report that is provided alongside the guideline document throughout the remainder of the approval processes and final publication.

The AAOS believes in the importance of demonstrating responsiveness to input received during the review process and welcomes the critiques of external specialty societies. Following final approval of the guideline, all individual responses are posted on our website http://www.aaos.org/quality with a point-by-point reply to each non-editorial comment. Reviewers who wish to remain anonymous notify the AAOS to have their names de-identified; their comments, our responses, and their COI disclosures are still posted.

THE AAOS CPG APPROVAL PROCESS

This final clinical practice guideline draft must be approved by the AAOS Committee on Evidence Based Quality and Value, and subsequently the AAOS Research and Quality Council, and the AAOS Board of Directors. These decision-making bodies are described in the CTS CPG eAppendix 1. Their charge is to approve or reject its publication by majority vote.

REVISION PLANS

This clinical practice guideline represents a cross-sectional view of current treatment and may become outdated as new evidence becomes available. This clinical practice guideline will be revised in accordance with new evidence, changing practice, rapidly emerging treatment options, and new technology. This clinical practice guideline will be updated or withdrawn in five years.

CPG DISSEMINATION PLANS

The primary purpose of the present document is to provide interested readers with full documentation of the best available evidence for various procedures associated with the topic of this review. Publication of most clinical practice guidelines is announced by an Academy press release, articles authored by the clinical practice guideline development group and published in the Journal of the American Academy of Orthopaedic Surgeons, and articles published in AAOS *Now*. Most clinical practice guidelines are also distributed at the AAOS Annual Meeting in the Resource Center. he final guideline recommendations and their supporting rationales will be hosted on www.OrthoGuidelines.org.

Selected clinical practice guidelines are disseminated by webinar, the AAOS Learning Management System (LMS), Media Briefings, and by distributing them at relevant Continuing Medical Education (CME) courses and at the AAOS Resource Center.

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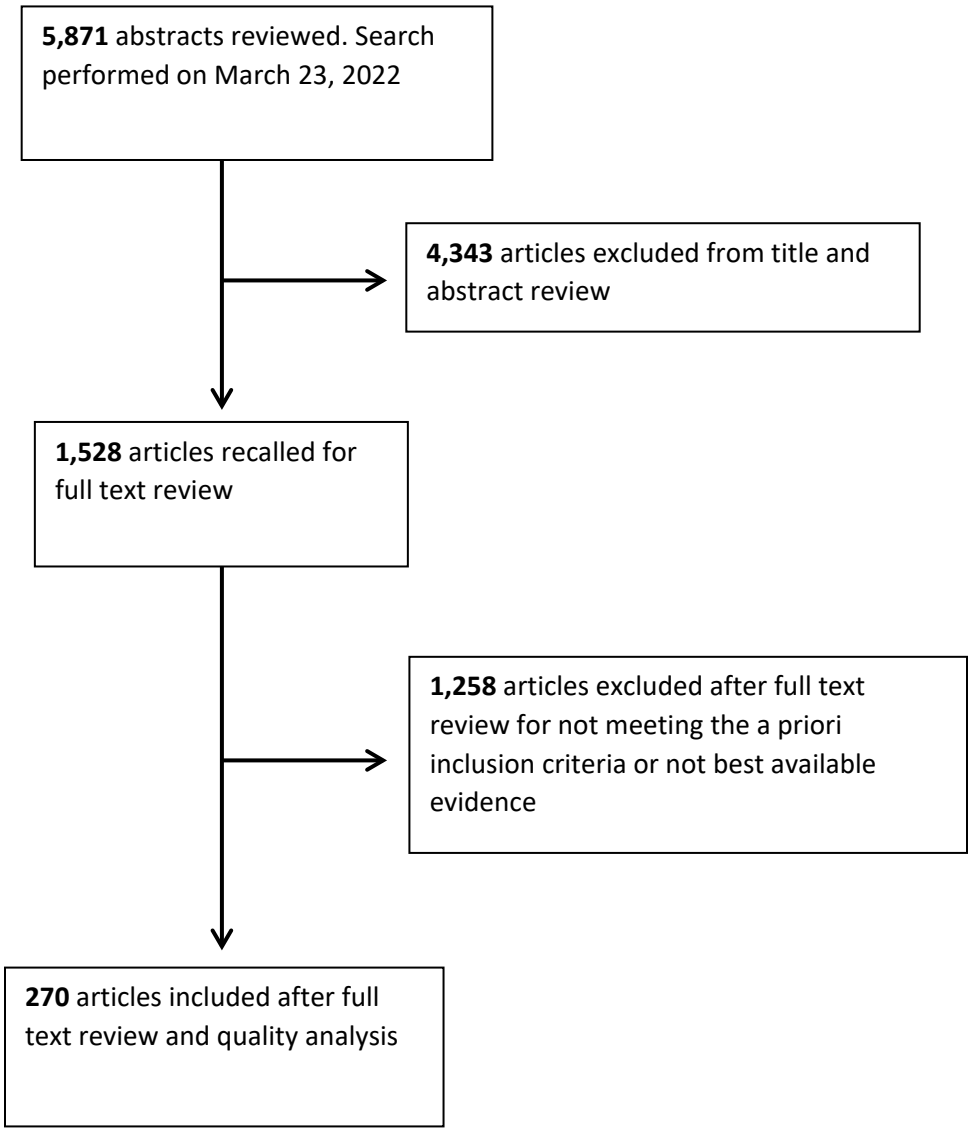
Study Attrition Flowchart



RECOMMENDATIONS

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Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

Rationale

There were ten high and five moderate quality studies supporting the use of either the CTS-6, NCV/EMG, and ultrasonography for the diagnosis of carpal tunnel syndrome (High-Quality: Wong 2004, Draghici 2020, Martikkala 2021, Falsetti 2022, Fu 2015, Moran 2009, Fowler 2014, Graham 2008, Wang 2020, Chen 2021) (Moderate-Quality: Mehrpour 2016, Mallouhi 2006, Naranjo 2007, Abdel Ghaffar 2012, Kanagasabai 2022). Although there was heterogeneity in the patient populations and comparisons for different studies there was strong and consistent evidence supporting these tools in diagnosing carpal tunnel syndrome. For example, Fowler 2014 studied ultrasonography versus NCV/EMG using CTS-6 as a reference standard (a tool that encompasses signs and symptoms used by clinicians to diagnose carpal tunnel syndrome) and found a positive predictive value of ultrasound and NCV/EMG of 94% and 89% respectively, and a negative predictive value of 82% and 80% respectively. In Fu 2015, the authors used clinical diagnosis of carpal tunnel along with NCV/EMG to test the use of ultrasonography and found a sensitivity and specificity of 91% and 93% respectively. In Graham 2008, NCV/EMG confirmation of carpal tunnel syndrome was used as the reference standard to test the correlation of the pre-test probability of having carpal tunnel syndrome using the CTS-6. The correlation of having carpal tunnel syndrome by using the CTS-6 compared to NCV/EMG diagnosis was as high as 0.9. There was no strong evidence demonstrating clinical superiority between diagnostic tools in this review, therefore we do not propose superiority of one test over the other, however, we highlight the use of CTS-6 as a diagnostic tool and/or screening tool, and the utilization of ultrasound or NCV/EMG as diagnostic tests when the positive predictive value when using the CTS-6 is low.

Benefits/Harms of Implementation

There is no specific research focused on the benefits/harms of the various modalities used to diagnose carpal tunnel syndrome that were found in this review. Roe (2022) found that from a shared decision-making perspective, patients want decision making for the testing for carpal tunnel diagnosis (ultrasound or NCV/EMG) to be equally collaborative. Harms of utilization of NCV/EMG include the unpleasant and invasive experience of the

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test, in addition to delays in treatment and costs. Similar harms related to delays and costs may be present for the utilization of ultrasound.

Outcome Importance

There was no evidence from this review that provided guidance for how the diagnostic tool used affected clinical outcomes.

Cost Effectiveness/Resource Utilization

While not the purpose of this systematic review, the guideline informs how future studies *assess* the cost effectiveness of testing for carpal tunnel syndrome.

Future Research

Future investigation can focus on differences in cost and patient outcomes based on diagnostic tools used.

DIAGNOSIS: MRI, UPPER LIMB NEURODYNAMIC TESTING

Moderate evidence suggests that MRI and Upper Limb Neurodynamic Testing should not be used to diagnose carpal tunnel syndrome.

Quality of Evidence: Moderate

Strength of Recommendation: Moderate ★★★☆

Evidence from two or more "Moderate" quality studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. Also requires no or only minor concerns addressed in the EtD framework.

Rationale

The evidence shows that MRI and Upper Limb Neurodynamic testing should not be used for carpal tunnel syndrome. For the use of MRI, only one moderate quality study (Jarvik 2002) was reviewed which reported there was low specificity with moderate sensitivity using this tool to diagnosis carpal tunnel of any severity. Their findings suggest MRI was a poor tool in the diagnostic algorithm for Carpal Tunnel syndrome. Similarly, the use of Neurodynamic testing is as a tool for the diagnosis of Carpal Tunnel Syndrome was evaluated in a randomized controlled trial (Beddaa 2022) with high quality evidence demonstrating poor specificity (47%) and moderate sensitivity (76%) compared to the reference standard of Electrodiagnostic testing. Overall, the recommendation above is based on moderate evidence with limited to moderate strength that MRI and Upper Limb Neurodynamic Testing should not be used in the standard work up for the diagnosis of carpal tunnel syndrome.

Benefits/Harms of Implementation

Based on available evidence with low Specificity and moderate Sensitivity for both MRI and Neurodynamic testing, outcomes show that neither test provides benefit in the diagnosis of carpal tunnel syndrome compared to other more appropriate tools (CTS-6, Ultrasound, electrodiganostics). These tests have associated costs to patients and health systems and appear to provide no improved accuracy in the diagnosis of this condition.

Outcome Importance

Given the availability of alternative methods of diagnosis, and the importance of appropriate diagnostic clarity for patients, the use of these tools for diagnosis is not recommended.

Cost Effectiveness/Resource Utilization

Considering the associated costs of MRI and Neurodynamic testing they provide poor cost effectiveness in the standard work up for a patient presenting with Carpal Tunnel syndrome. This is important given the relative cost and availability differences between these tools and clinical exam testing (CTS-6) and the low-cost availability of alternatives.

Acceptability

Overall, the acceptability of this recommendation is expected to be high as obtaining MRI and Neurodynamic testing is not common practice. In addition, the associated costs and the potential for poor diagnostic clarity given the limited specificity of these tests make the value attached to use poor.

Feasibility

Because of the alternative diagnostic options for carpal tunnel syndrome, including exam alone (CTS-6), it is feasible to not utilize MRI or neurodynamic testing in the evaluation of a patient for carpal tunnel syndrome.

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Future Research

Additional high-quality studies should compare MRI and Neurodynamic testing against other standards of diagnosis outside of CTS-6, ultrasound, or electrodiagnostic testing if there were a hypothesis on a diagnostic advantage (e.g., improved specificity/sensitivity compared to alternate tests).

CORTICOSTEROID INJECTION

Strong evidence suggests corticosteroid injection does not provide long-term improvement of carpal tunnel syndrome.

Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

Rationale

While many high-quality studies addressed efficacy of corticosteroid steroid injections (CSI), either as a primary intervention or comparison group, fewer included long term follow up. Three high quality studies with follow up ranging from 6 months to 5 years demonstrated no benefits (Hofer 2021, Salman 2018, Atroshi 2013). A study comparing CSI to nighttime immobilization found no significant differences at 1-2 years (Burton 2022) and an additional study comparing CSI to prolotherapy also showed no difference at 1 year (Aghaei 2021). Taken together, there is strong evidence that, while there may be short-term improvement in symptoms with CSI, there is no long-term benefit.

Benefits/Harms of Implementation

CSI may provide short term improvement in symptoms. A therapeutic injection may cause localized pain and swelling, rare allergic reactions, and a small possibility of nerve damage.

Outcome Importance

CSI are very common and popular interventions with high utilization in clinical practice, thus this recommendation informs standard treatment for many surgeons.

Cost Effectiveness/Resource Utilization

CSI are, individually, inexpensive interventions relative to many other treatments. Limited data address cost-effectiveness.

Acceptability

We expect this recommendation to be generally accepted, however, CSI for short term relief of symptoms may continue.

Feasibility

Minimizing use of CSI for any long-term benefit is readily available and feasible.

Future Research

Future investigation can focus on assessing the short-term benefits to patients, in relation to the cost, to evaluate the cost-effectiveness and value of CSI, given the lack of long-term effectiveness.

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PLATELET-RICH PLASMA (PRP) INJECTION

Strong evidence suggests PRP Injection does not provide long-term benefits in non-operative treatment of carpal tunnel syndrome (leukocyte rich or leukocyte poor PRP).

Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

Rationale

A randomized controlled trial with 12-month follow-up of PRP vs saline control showed similar improvement in symptom severity scale and functional status at all time points without clinically meaningful differences, though cross-sectional area and electrodiagnostic parameters showed some beneficial effect from PRP (Chen, 2021). While other high-level studies failed to follow patients long-term, short-term effects of PRP have shown mixed results. Raeissadat (2018) conducted a randomized controlled trial that compared the effects of wrist splitting alone versus wrist splinting combined with a single local PRP injection. They found that over the 10-week treatment period in comparison to control, a single PRP injection did not significantly enhance the effects of conservative treatment in terms of pain, symptom severity, functional status, and electrophysiological parameters. In contrast, Malhias (2018) performed an RCT which found PRP lead to increased success rates defined by a 25% difference in Q-DASH scores in comparison to placebo at 12 weeks.

Benefits/Harms of Implementation

PRP is an endogenously sourced blood product. Harvesting requires venipuncture and risks of injection are low. Benefits are unclear.

Cost Effectiveness/Resource Utilization

PRP is relatively expensive due to the cost of purification and separation equipment necessary to isolate and extract the platelet-rich fraction from whole blood. With no clear benefit to patient outcomes, its utilization may be wasteful.

Acceptability

PRP is performed by many practitioners despite limited evidence of effectiveness. It is not considered a standard treatment for carpal tunnel syndrome.

Feasibility

Implementation of this recommendation is feasible as it recommends against the use of PRP for the treatment of carpal tunnel syndrome.

Future Research

There are few placebo-controlled trials of PRP with long-term follow up. More high-level research with longer follow up is critical to evaluating any significant differences between PRP and placebo.

SURGICAL RELEASE TECHNIQUE

Strong evidence suggests that there is no difference in patient reported outcomes between a mini-open carpal tunnel release and an endoscopic carpal tunnel release.

Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

Rationale

There are multiple high and moderate quality studies that were identified to evaluate the difference in outcomes between a mini-open carpal tunnel release and an endoscopic carpal tunnel release. These studies consistently demonstrated no difference in long-term outcomes (e.g., patient reported outcome measures, range of motion, grip strength) between the two techniques (Oh 2017, Kang 2013, Larsen 2013, Aslani 2012, Wang 2022, Capa-Grasa 2014). We used mini-open carpal tunnel release as a term to describe a small incision in the palm that does not cross the wrist crease, which is smaller in size than more traditional open approaches.

Benefits/Harms of Implementation

There is no consistently demonstrated benefit of utilizing a mini-open carpal tunnel release or an endoscopic carpal tunnel release. Endoscopic carpal tunnel release may afford a shorter return to work however this may depend upon post operative protocols, patient occupation, and other factors. Endoscopic carpal tunnel release can be associated with greater costs, which may affect patient preference for this option. Although not included in this review, complication rates for endoscopic carpal tunnel release may be higher than previously described and should be considered (Carrol 2023).

Cost Effectiveness/Resource Utilization

Cost data regarding endoscopic and mini open carpal tunnel release vary and are based upon several factors including surgical location (e.g., office, operating room) and stakeholder perspective (e.g., societal, payer) (Barnes 2021, Zhang 2016). Prior studies evaluating the cost effectiveness of these approaches have favored mini-open carpal tunnel release when completed in the office setting, however, advances in endoscopic release in the office may need to be considered. Recent literature on higher complication rates with endoscopic release may affect future CAEs on this topic.

Acceptability

Mini-open and endoscopic release are both accepted surgical techniques for carpal tunnel release.

Feasibility

Both techniques are feasible, however each technique should be performed only by those who are trained in each technique.

Future Research

Future investigations can focus on the development of tools to help guide patients in understanding the benefits, risks, and costs associated with each technique to support a shared decision-making approach that aligns with patient preferences.

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Strong evidence suggests local anesthesia alone can be used for carpal tunnel release.

Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

Rationale

There are three high quality and six low quality studies that suggest local anesthesia alone can be used for carpal tunnel release. Three randomized controlled trials evaluated local anesthesia as compared to intravenous regional anesthesia (Nabhan 2011, Okamura 2021, Sorensen 2013). One study demonstrated decreased tourniquet time and OR time in the local anesthesia cohort with no differences in patient reported outcomes (Nabhan 2011). Another study demonstrated lower intraoperative and postoperative pain and analgesic use in the local anesthesia cohort (Okamura 2021). Sorensen et al, demonstrated that patients in the local anesthesia cohort reported less postoperative pain and analgesic use. Lower quality studies have demonstrated adequate and/or improved pain control in the local anesthetic cohort (Kang 2019), low or no increased risks of complications (Rellan 2021, Wellington 2021), and similar patient reported outcomes as compared to other anesthetic modalities (Tulipan 2017, Tulipan 2018).

Benefits/Harms of Implementation

There are potential benefits and harms associated with local anesthetic and intravenous regional anesthesia that should be discussed with patients. For example, local anesthetic may allow for flexibility in procedure location (e.g., office-based surgery) and ability to drive oneself home, however it may be anxiety provoking for some patients. A shared decision-making approach on the use of local only for surgery may be beneficial.

Cost Effectiveness/Resource Utilization

Cost effectiveness and resource utilization were not primary outcomes of this review, and costs and resource utilization vary based upon context, however in general, carpal tunnel release with local anesthetic results in lower costs and resource utilization compared to other forms of anesthesia (e.g., monitored anesthesia care) (Carr 2019, Kamal 2019).

Acceptability

Based on descriptions in the literature, local anesthesia has been adopted by surgeons and patients in multiple countries as an acceptable approach for carpal tunnel release.

Feasibility

Local anesthesia is readily available and feasible as it does not require any additional medications or changes to the surgical approach.

Future Research

Future investigation can focus on the development of tools to help understand patient preference and guide patients in understanding the benefits, risks, and costs associated with available anesthetic techniques. The financial advantages of local only anesthesia may be further explored in future cost effectiveness analyses.

POSTOPERATIVE THERAPY

Moderate evidence suggests postoperative supervised therapy should not be routinely prescribed after carpal tunnel release.

Quality of Evidence: Moderate

Strength of Recommendation: Moderate 

Evidence from two or more "Moderate" quality studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. Also requires no or only minor concerns addressed in the EtD framework.

Rationale

This recommendation is based on one high-quality, two moderate-quality, and one low-quality study evaluating the use of physical therapy after carpal tunnel release (Provinciali 2000, Pomerance 2007, Schroeder 2022, Gil 2020). These studies consistently demonstrate that there are no functional or outcome benefits of using therapy after carpal tunnel release. There was one high-quality study that demonstrated short term benefits (of improved motor dexterity at one month and shorter return-to-work) (Provinciali 2000).

Benefits/Harms of Implementation

The benefit of the use of therapy after carpal tunnel release has not been demonstrated. Its use may result in unnecessary costs (direct, indirect, intangible). There may be scenarios or patients in whom post-operative therapy may be beneficial, however, studies are required to identify this potential patient population. While formal physical therapy is not substantiated across the majority of patients, it may benefit some patients on a case-by-case basis.

Future Research

Future research is needed to determine which patients may benefit from physical therapy after carpal tunnel release. Research evaluating the cost-effectiveness of physical therapy post-operatively, particularly in specific patient populations, may be beneficial to promote high-quality low-cost care.

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POSTOPERATIVE IMMOBILIZATION

Moderate evidence suggests immobilization through sling or orthosis (e.g., splint, brace) should not be used after carpal tunnel release.

Quality of Evidence: Moderate

Strength of Recommendation: Moderate 

Evidence from two or more "Moderate" quality studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. Also requires no or only minor concerns addressed in the EtD framework.

Rationale

This recommendation is based on one high-quality, five moderate-quality, and one low-quality study evaluating the use of postoperative splinting in comparison to no splinting. These studies demonstrate that there are no functional or outcome benefits of utilizing splinting after carpal tunnel release.

One high-quality article (Logli 2018) demonstrated no difference in patient reported or clinical outcomes at any follow up period to 12 months after mini-open CTS surgery in patients who utilized a non-removable orthotic (plaster, Webril cotton wrap) or patients who used a soft dressing (gauze wrap) when compared to a removable orthotic (V-Strap wrist brace).

One moderate-quality article (Cebesoy 2007) showed that patients who had been treated with a surgical intervention for CTS had a significantly better BCTQ-SSS score when treated with a post-op Bulky Bandage than patients who were treated with a splint.

One moderate-quality article (Ritting 2012) showed that patients treated with early mobilization after surgical intervention for CTS had better grip strength and tip pinch strength than patients treated with medicated gauze, cotton gauze, cast padding, and elastic roller bandage.

One moderate-quality article (Cook 1995) showed that patients who began range of motion exercises after CTS surgery post-op day one had significantly better outcomes in return to daily living, light duty work, and full duty work than patients who were splinted for two weeks following surgery. Grip strength, key-pinch strength, and VAS pain were also improved in the unrestricted movement group, however these effects only lasted until the one-month follow-up.

Two moderate-quality articles (Finsen 1999 and Huemer 2007) and one low-quality article (Kroeze 2020) showed no significant differences in observed outcomes between their restricted and unrestricted movement groups.

Benefits/Harms of Implementation

There are no harms associated with implantation of this recommendation.

Future Research

Future investigation should focus on determining benefits of early post operative mobilization, return to unrestricted activities of daily living and work activities.

POSTOPERATIVE PAIN: NSAID, ACETAMINOPHEN

Strong evidence suggests that NSAIDs and/or acetaminophen should be used after carpal tunnel release for postoperative pain management.

Quality of Evidence: High

Strength of Recommendation: Strong ★★★★

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Also requires no reasons to downgrade from the EtD framework.

Rationale

One high-quality article (Husby 2001) showed no significant differences in observed outcomes for patients who underwent surgery for CTS treated with acetaminophen vs. patients that were given matching placebo pills. Three high-quality articles (Husby 2001 and Ilyas, 2018/2019) showed no significant differences in observed outcomes for patients who underwent surgery for CTS treated with acetaminophen vs. those who were given non-steroidal anti-inflammatory drugs (NSAIDs) (Naproxen or ibuprofen). Ilyas (2018) also showed that the patients who took acetaminophen or ibuprofen after mini-open carpal tunnel repair had statistically significantly lower Worst Daily Pain (0-10 scale) than those who took Oxycodone – 2.5 and 3.4 respectively. Ilyas (2019) again showed that the patients who underwent CTS surgery who took acetaminophen or ibuprofen also had less VAS Worst Daily Pain than patients who took Oxycodone – 2.5, 2.5, and 2.9 respectively; these differences reached statistical significance. Adverse events were also significantly less common in patients taking NSAIDs or acetaminophen in comparison to Oxycodone. Ilyas 2018 reported 11% of the oxycodone group reported adverse events compared to 3% in the acetaminophen group; Ilyas 2019 adverse events were reported in 15% of the oxycodone group, 1.6% of the acetaminophen group, and 1.6% in the NSAID group.

Benefits/Harms of Implementation

The benefit of having two non-opioid medications for postoperative pain management is that pain can still be managed despite concomitant conditions, which may preclude a patient from taking either NSAID or acetaminophen. In addition, this helps avoid the many adverse effects of opioids (overdose and addiction).

Outcome Importance

NSAIDs and acetaminophen are options to help control postoperative pain.

Acceptability

Accepted treatment for pain in the postoperative state as there are over-the-counter medications.

Feasibility

Feasible as these are over-the-counter medications that are familiar to patients and clinicians.

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OPTIONS

Low quality evidence, no evidence, or conflicting supporting evidence have resulted in the following statements for patient interventions to be listed as options for the specified condition. Future research may eventually cause these statements to be upgraded to strong or moderate recommendations for treatment.

RISK FACTORS: KEYBOARDING, CLERICAL WORK

In the absence of reliable evidence, it is the opinion of the workgroup that there is no association between high keyboard use and carpal tunnel syndrome.

Quality of Evidence: Very Low
Strength of Option: Consensus 

Description: Evidence there is no supporting evidence, or limited level evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.

Rationale

No high- or moderate-quality studies were identified to address the question of the association of keyboard use and carpal tunnel syndrome. A single low-quality study that met inclusion criteria, (Eleftheriou et al. 2012), reported a statistically significant association between high keyboard use and carpal tunnel syndrome.

Benefits/Harms of Implementation

This recommendation is based upon a research question that was specifically focused on the association of high keyboard use and carpal tunnel syndrome. The potential harm in the CPG lies in the lack of recognition of keyboard use as a strong risk factor or causative variable for carpal tunnel syndrome which has implications for worker's compensation cases and physicians called upon to evaluate causation.

THERAPEUTIC ULTRASOUND

Evidence suggests therapeutic ultrasound does not provide long-term improvement of carpal tunnel syndrome.

Quality of Evidence: High

Strength of Option: Limited ★★☆☆ (Downgraded)

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Option was downgraded based on EtD framework.

Rationale

There is limited standardization of the studies assessing the effectiveness of therapeutic ultrasound on carpal tunnel symptoms; this recommendation has been downgraded for inconsistency and heterogeneity of both treatments and outcomes. Studies were inconsistent with the use of constant versus pulsed-wave treatments as well as dosages and supplementing treatment with an orthosis. Only one study provided long term follow up (Jothi, 2019) and showed no significant difference between therapeutic ultrasound and sham ultrasound therapy. Two additional papers also showed no significant difference between treatment and control groups, although the follow up was only one to two months (Catalbas 2018 and Yildiz 2011). Only one paper favored the use of ultrasound for treatment of CTS (Dincer, 2009) while Ebenbichler et al. Showed more mixed results in 1998. Many studies evaluated therapeutic ultrasound against various other treatments, including, exercise, phonophoresis, pulsed radiofrequency, heat and laser therapy, however, ultrasound was not clearly superior. There was limited standardization of the use of therapeutic ultrasound on carpal tunnel symptoms, such as the use of constant versus pulsed-wave treatments as well as dosages.

Benefits/Harms of Implementation

Therapeutic ultrasound does not show any significant difference from placebo. Although it does not have any direct biological adverse reactions, ultrasound adds to the time and cost of treatment without established benefit to patients. There are no harms expected from this recommendation based on the evidence.

Cost Effectiveness/Resource Utilization

Given the lack of effectiveness of therapeutic ultrasound, it is not cost effective to use it as a therapy for CTS.

Acceptability

Due to lack of supporting evidence, this guidance is anticipated to be accepted by surgeons, patients, and therapists.

Feasibility

Readily available and feasible to not use this modality.

Future Research

More long-term follow up studies are required to confirm the lack of effectiveness of therapeutic ultrasound in the treatment of CTS.

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NON-OPERATIVE TREATMENTS VS. PLACEBO/CONTROL

Evidence suggests that the following non-operative treatments do not demonstrate superiority over control or placebo: acupressure, insulin injection, heat therapy, magnet therapy, nutritional supplementation, oral diuretic, oral NSAID, oral anticonvulsant, phonophoresis.

Quality of Evidence: High

Strength of Option: Limited ★★☆☆ (Downgraded)

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Option was downgraded based on EtD framework.

Rationale

The overall strength was downgraded for this option given the heterogeneity in treatment modalities, study quality, control cohort utilized, and follow-up time periods. Single studies evaluating acupressure, insulin injection, heat therapy, immobilization, oral diuretic, and oral NSAID for the treatment of CTS showed no significant difference at short term follow up (Asgari, 2020, Kamel 2019, Mansiz Kaplan 2019, Kocak Ulucakoy 2020, Chang 2020). Two studies showed moderate evidence that there was no significant difference between patient treatment with magnet therapy and controls (Colbert 2010 and Baute 2018). Patients treated with nutritional supplementation did not show improvement over controls in two studies (Paolucci 2018 and Faig-Marti 2017), however, showed improvement in a single study with very short term follow up (Marvulli 2021). There is strong evidence that oral anticonvulsants are not effective in the treatment of CTS with three out of four articles showing no significant difference between treatment and placebo groups (Hui 2011, Eftekharsadat 2015, Mehmetoglu 2018, Hesami 2018). Lastly, there is strong evidence against the use of phonophoresis to treat CTS (Boohong 2020 and Haghighat 2021).

Benefits/Harms of Implementation

The above treatments do not show a consistent significant difference from control groups and add to the time and monetary expense for patients suffering from CTS and to the health system (low value care). Moreover, adverse reactions from oral diuretics, NSAIDs and anticonvulsants are well recognized and are discouraged for non-operative treatment of CTS through this guideline.

Outcome Importance

As the above treatments do not show a difference in symptom improvement for CTS, they should not be recommended.

Cost Effectiveness/Resource Utilization

Given the lack of effectiveness of the above treatments are not considered cost effective to treat CTS.

Future Research

No long-term follow up studies are available to confirm the lack of effectiveness of these therapies, however, are likely not necessary, given the lack of short-term benefits.

NON-OPERATIVE TREATMENTS: LONG-TERM

Evidence suggests the following non-operative treatments do not improve long-term patient reported outcomes for carpal tunnel syndrome: oral corticosteroid, hyaluronic acid injection, hydro dissection, kinesiotaping, laser therapy, peloid therapy, perineural injection therapy, topical treatment, shockwave therapy, exercise, ozone injection, massage therapy, manual therapy, pulsed radiofrequency.

Quality of Evidence: High

Strength of Option: Limited ★★☆☆ (Downgraded)

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Option was downgraded based on EtD framework.

Rationale

The overall strength was downgraded for this option given the heterogeneity in treatment modalities, study quality, control cohort utilized, and follow-up time periods. One study evaluating oral corticosteroid (Chang 1998). Two studies evaluating hyaluronic acid injection demonstrate limited evidence in favor of hyaluronic acid injection at 6 months as compared to a normal saline injection (Wu 2022) and no difference between a hyaluronic acid and normal saline injection at 1-, 3-, and 6-mo follow up time points (Su 2021).

There are three studies that evaluated the utilization of hydro dissection for the treatment of carpal tunnel syndrome. Elawamy et al.2020 demonstrated improved pain and function 6 months after hydro dissection with Hyalase and 10 mL saline solution injection as compared to hydro dissection with 10mL of saline solution only. We et al.2018 demonstrated that hydro dissection resulted in improved function and symptom severity compared to subcutaneous injection at 6mo. He et al.2022 demonstrated that hydro dissection with 5% dextrose as an add on to a corticosteroid injection resulted in improved patient reported outcome scores at 3 mo.

Five studies evaluated kinesiotaping, two favoring kinesiotaping and three demonstrating no difference as compared to various treatment modalities including an orthosis, placebo kinesiotaping, nerve and tendon gliding exercises (Geler 2016, De Sire 2021, Aminian 2022, Mansiz 2019, Yildririn 2018).

Seven studies evaluated the utilization of laser therapy, four of which were either mixed or favored laser therapy whereas three demonstrated no difference in outcomes when comparing laser therapy to orthosis and/or placebo (Barbosa 2016, Chang 2008, Dincer 2009, Evic 2007, Fusakul 2014, Guner 2018, Yagci 2019). Metin et al.2017 evaluated peloid treatment with nighttime orthosis as compared to nighttime orthosis alone and demonstrated improvements in functionality at one month.

Wu et al.2017, when comparing perineural injection therapy with 5% dextrose to perineural injection therapy with normal saline, demonstrated clinical improvement in the former group at 6 months post injection. Five studies evaluated the use of topical treatments (e.g., lavender oil, chamomile oil) that demonstrated varied results as compared to placebo (Eftekharsadat 2018, Flondell 2017, Hashempur 2015, Karimi 2021, Hashempur 2017.

Ten studies evaluate short term (up to 6-month) effects of shockwave therapy, eight of which demonstrate benefits and two of which demonstrate no difference in outcomes as compared to sham treatment, (Habibzadeh 2022, Kocak 2020, Gesslbauer 2021, Chang 2020, Wu 2016, Vahdatpour 2016, Saglam 2022, Haghighat 2021,

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Raissi 2017, Karatas 2019). Six studies evaluated exercise therapy or neuromobilization for the treatment of carpal tunnel syndrome. There was great variation in the intervention protocols (Shem 2020, Zidkova 2019, Abdolrazaghi 2021, Hesami 2018, Salehi 2019). Shem 2020 showed symptom improvements after 6 weeks of self-myofascial stretching. Zidkova 2019 showed 9-week improved symptom scores after exercise with neuromobilization techniques. Abdorlrazaghi 2021 found that a 6-week gliding exercise with splinting protocol did not provide improvement in comparison to splinting alone. Hesami 2018 and Salehi similarly showed nerve and gliding tendon exercises provide benefit in comparison to splinting alone after 6-week protocols.

Bahrami (2019) evaluated ozone injection with splinting as compared to splinting alone and demonstrated clinical improvement in the intervention arm. Elbalawy 2020 compared sensory rehabilitation with physical therapy as compared to physical therapy alone for carpal tunnel syndrome and demonstrated no difference in cohorts.

Four studies evaluate various manual therapies for the treatment of carpal tunnel syndrome. Despite various therapy modalities and time periods of follow up, each study favors manual therapy as compared to the control cohort. Jimenez Del Barrio 2018 investigated diacutaneous fibrolysis; Wolny investigated neurodynamic techniques administered twice per week for ten weeks in both 2018 and 2019. Dinarvand 2017 compared hamate and scaphoid mobilization with splinting with splinting alone and found that while both groups improved significantly at ten-week follow-up, the degree of improvement was larger in the mobilization group. Chen 2015 compared ultrasound-guided pulsed radiofrequency treatment with night splinting as compared to night splinting alone and demonstrated improved pain and functional outcome scores in the intervention cohort. Weintraub et al. evaluated the use of static and pulsed electromagnetic fields for the treatment of carpal tunnel and noted improvements in pain as compared to sham treatment.

Benefits/Harms of Implementation

The above interventions do not demonstrate a consistently significant difference as compared to control cohorts. Each treatment is associated with its own time and monetary expense, as well as risk profile.

Cost Effectiveness/Resource Utilization

Given the lack of effectiveness of the above treatments, they are not considered cost effective for the treatment of carpal tunnel syndrome.

Acceptability

Due to lack of supporting evidence, this guideline is anticipated to be accepted by surgeons, patients, and therapists.

Future Research

Future research may include studies that compare non operative treatment options to carpal tunnel release and/or with a more consistently defined intervention and/or control cohort.

COMPARISON OF NON-OPERATIVE TREATMENTS

Evidence suggests no significant difference in patient reported outcomes between non operative treatment techniques for carpal tunnel syndrome.

Quality of Evidence: High

Strength of Option: Limited ★★☆☆ (Downgraded)

Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention. Option was downgraded based on EtD framework.

Rationale

Numerous articles compared various therapies for carpal tunnel against other therapies. Not only were the treatments and their comparisons very heterogeneous, but no long-term follow also up was described either – as such, this recommendation has been downgraded. The majority of the studies did not demonstrate any significant difference between the treatment arms. When comparing corticosteroid injection versus shockwave therapy, the results were equivocal with one study out of four favoring ESWT, another favoring CSI, and two showing no significant difference between the treatment groups. When comparing ESWT with various treatments, three studies showed a slight benefit in ESWT.

Benefits/Harms of Implementation

The above non operative treatments do not show a consistent significant difference from other treatments and add to the time and monetary expense for patients suffering from CTS.

Outcome Importance

As there is limited data with mixed quality of evidence, any particular non-operative treatment cannot be recommended over another non-operative treatment.

Cost Effectiveness/Resource Utilization

None of the non-operative treatments have shown long-term success in the treatment of CTS and therefore, are not considered cost-effective options.

Acceptability

Due to lack of supporting evidence, this guideline is anticipated to be accepted by surgeons, patients, and therapists.

Feasibility

Readily available and feasible to not use these modalities.

Future Research

No long-term follow up studies are available to confirm the lack of effectiveness of these therapies, however, are likely not necessary, given the lack of short-term benefits.

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SITE OF SERVICE

Limited evidence suggests carpal tunnel release may be safely conducted in the office setting.

Quality of Evidence: Low

Strength of Option: Limited 

Description: Evidence from one or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for or against the intervention. Also, higher strength evidence can be downgraded to limited due to major concerns addressed in the EtD Framework.

Rationale

No high- or moderate-quality studies were identified to address the question related to the association of site of carpal tunnel release on outcomes. Five low-quality studies were identified, most of which were single-surgeon, single-institution and/or retrospective or database studies evaluating carpal tunnel release conducted in the office setting as compared to the operating room setting (Halvorson 2020, Miller 2022, Moscato 2021, Randall 2021, Stephens 2021). These studies consistently demonstrated that carpal tunnel release in the office setting results in no increased risk of complications with higher ratings of patient experience and satisfaction when compared to surgical release in the operating room.

When examining surgical site infection (SSI) rates, Halvorson et al. (2020) discerned no significant disparity between clinic-based procedure rooms (PR) and traditional operating rooms (OR). In terms of patient experience and satisfaction, Miller (2022) highlighted the advantages of office-based procedures utilizing wide awake local anesthesia (WALANT). Patients in the office reported heightened enjoyment, reduced anxiety, and an overall more positive experience compared to those in the OR. Exploring patient satisfaction in relation to anesthesia and surgical settings, Moscato's study (2021) illuminated the superiority of office-based CTR surgeries with WALANT over hospital-based procedures with regional anesthesia and sedation. This was underscored by consistent correlations between WALANT anesthesia and enhanced patient satisfaction across settings. Regarding medical complications, Randall (2021) revealed comparable safety profiles for office-based procedure rooms (PR) and OR settings. Notably, no substantial differences were found in major medical, surgical site, or iatrogenic complications between office and OR environments, underscoring the safety of CTR procedures regardless of the chosen setting.

Lastly, Stephens' study (2021) evaluated long-term outcomes after open CTR procedures. The transition from OR to PR in 2014 did not yield discernible discrepancies in patient demographics or postoperative outcomes measured using the Boston Carpal Tunnel Questionnaire (BCTQ), highlighting the enduring clinical effectiveness of CTR procedures across various procedural environments.

Benefits/Harms of Implementation

The benefits of surgical release in the office as compared to the operating room include potential time and cost savings for patients and hospital systems. There are also potential improvements in the patient experience with office based carpal tunnel release. Notably, patients eligible for office-based procedures should be appropriately chosen and willing to undergo surgical release awake with limited anesthesia.

Future Research

Future research should include randomized controlled trials of office vs OR based carpal tunnel release and cost effectiveness analyses of moving cases from the OR to the office.

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SURGICAL DRAPING

In the absence of reliable evidence, it is the opinion of the workgroup that limited draping is an option for carpal tunnel release.

Quality of Evidence: Consensus
Strength of Option: Consensus ★☆☆☆

Description: Evidence there is no supporting evidence, or limited level evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.

Rationale

There are no randomized trials of draping options or field sterility relevant to this question. Multiple case series of WALANT surgeries, including carpal tunnel release, have shown low infection rates using field sterility. Given the well-documented cost savings of in-office carpal tunnel release using field sterility and the low reported infection rates for carpal tunnel release in general, it is our opinion that field sterility should be considered adequate for performance of carpal tunnel release surgery.

Benefits/Harms of Implementation

Given the low risk of infection in CTR overall, the harms are minimal. Benefits apply largely to efficiency and cost of in-office or surgical suite CTR surgery where full operative draping may not be feasible.

Cost Effectiveness/Resource Utilization

Field sterility or minimal draping is less expensive than full operative draping and contributes to the cost-effectiveness of CTR.

Acceptability

Well accepted approach in the literature in multiple health system settings.

Feasibility

No feasibility issues are expected as this approach minimizes the use of potentially unnecessary draping.

Future Research

Randomized controlled trials of field sterility in hand surgery are lacking and would strengthen the evidence against their use.

ANTICOAGULATION

Limited evidence suggests anticoagulation medication may be safely continued for carpal tunnel release.

Quality of Evidence: Low

Strength of Option: Limited ★★☆☆

Description: Evidence from one or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for or against the intervention. Also, higher strength evidence can be downgraded to limited due to major concerns addressed in the EtD Framework.

Rationale

Two low quality studies provide limited evidence suggesting that anticoagulation medication may be safely continued for carpal tunnel release. Kaltenborn (2019) utilized propensity score matching to evaluate the association of bleeding complications with acetylsalicylic acid use in patients undergoing carpal tunnel release and demonstrated no difference in bleeding outcomes between the acetylsalicylic acid cohort and the control cohort. Brunetti (2013) similarly demonstrated no difference in complications between cohorts undergoing carpal tunnel release taking acetylsalicylic acid and those not taking acetylsalicylic acid. Although not included in the guideline given the lack of results specific to carpal tunnel syndrome, a single-center, prospective cohort trial (Bogunovic 2015) evaluated the impact of uninterrupted Warfarin use on hand and wrist surgery. When case matched to those not prescribed Warfarin, those prescribed Warfarin (with an INR<3.5) demonstrated an infrequent risk of bleeding complications requiring reoperation.

Benefits/Harms of Implementation

The benefits and harms of continuing anticoagulation vary based upon the indication for the specific anticoagulation. From a surgical perspective, the harm in continuing anticoagulation may include complications related to bleeding, however this has not been definitively demonstrated in the literature.

Cost Effectiveness/Resource Utilization

Continuation of anticoagulation medication may prevent unnecessary visits to a patient's cardiologist and/or medical team to inquire and/or obtain counseling related to pausing or bridging medications.

Acceptability

Use of anticoagulants is accepted practice but may vary based upon type of anticoagulation, patient factors, and surgeon preference.

Feasibility

No issues related to feasibility beyond the anticipated discussion on risks of bleeding/hematoma when continuing on anticoagulation medication.

Future Research

Future research should be conducted to explore various types of anticoagulation and to increase the quality of evidence.

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PROPHYLACTIC PERIOPERATIVE ANTIBIOTICS

Limited evidence suggests perioperative prophylactic antibiotics are not indicated for the prevention of surgical site infection following carpal tunnel release.

Quality of Evidence: Low

Strength of Option: Limited 

Description: Evidence from one or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for or against the intervention. Also, higher strength evidence can be downgraded to limited due to major concerns addressed in the EtD Framework.

Rationale

Four low quality studies demonstrate limited evidence suggesting that perioperative prophylactic antibiotics are not indicated for the prevention of surgical site infection following carpal tunnel release. Multiple retrospective reviews have demonstrated that the use of prophylactic antibiotics for carpal tunnel release does not decrease the rate of infection, even in patients with diabetes (Harness 2010, Mehta 2022, Tosti 2012, Vasconcelos 2017). A claims database study evaluating the effectiveness of perioperative antibiotics for common soft tissue hand procedures that controlled for several patient demographic factors through propensity score matching demonstrated no difference in infection rates between cohorts with and without perioperative prophylactic antibiotics (Li, 2018). Notably, this study, despite including over 60,000 patients undergoing carpal tunnel release (>50% of included patients) was not included in the evidence as the infection rate was not detailed by condition.

Benefits/Harms of Implementation

The benefit of perioperative prophylactic antibiotics is the prevention of surgical site infection; however, this has not been demonstrated in the literature. The harm of perioperative prophylactic antibiotics includes risks related to the side effects of antibiotics (allergic reactions, development of drug-resistant organisms, and Clostridium difficile infection) without the proven benefit of reducing infections.

Cost Effectiveness/Resource Utilization

There are costs associated and resources utilized in the delivery of perioperative antibiotics and the treatment of downstream adverse effects.

Acceptability

It is accepted practice to limit the overuse of antibiotics although not strictly practiced by all surgeons due to other guidelines for major surgery that support the routine administration of preoperative antibiotics (e.g., total joint arthroplasty).

Feasibility

There are no feasibility issues with the implementation of this recommendation as it suggests limited unnecessary care.

Future Research

Future research should address the strength of recommendation through more condition-specific analyses for the use of preoperative antibiotics.

PREOPERATIVE TESTING

In the absence of sufficient evidence specific to carpal tunnel, it is the opinion of the workgroup that routine pre-operative testing (e.g., labs, CXR, EKG) is not indicated.

Quality of Evidence: Very Low
Strength of Option: Consensus ★☆☆☆

Description: Evidence there is no supporting evidence, or limited level evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.

Rationale

There are no studies evaluating the utilization of pre-operative testing (e.g., labs, CXR, EKG) for carpal tunnel patients only. One study evaluated the use of pre-operative testing for patients with common hand conditions (including carpal tunnel) and demonstrated increased generation of downstream tests, procedures, and costs. Studies outside of hand surgery consistently demonstrate that pre-operative testing for healthy patients undergoing minor procedures leads to delays in care, unnecessary downstream testing and care, and added costs.

Benefits/Harms of Implementation

The potential benefits of this recommendation include decreasing the utilization of unnecessary testing that has the potential to lead to increased costs, delays in care, and downstream care cascades. The potential harm is missing a critical test result that may impact care or the patient's health. In healthy patients, this risk and thus potential harm is low. As such, the working group recommends that peri-operative testing not be performed routinely on healthy patients before carpal tunnel release and may be utilized on a case-by-case basis for non-healthy patients when it may impact their anesthetic type or peri-operative care.

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ADJUNCTIVE TESTING

In the absence of reliable evidence, it is the opinion of the workgroup that, when multiple risk factors for amyloidosis are present, pathological analysis of tenosynovium may be performed.

Quality of Evidence: Consensus
Strength of Option: Consensus ★☆☆☆

Description: Evidence there is no supporting evidence, or limited level evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.

Rationale

Amyloidosis has various clinical manifestations that can include cardiac dysfunction. Carpal tunnel is often one of the earliest clinical manifestations of amyloidosis (Nakagawa 2016). A recent cross-sectional study of patients with carpal tunnel syndrome undergoing carpal tunnel release showed that 10.2% exhibited amyloid deposits on tenosynovial biopsy, leading 4% to disease-modifying treatment. Although the diagnosis of amyloidosis is rare, given the lack of high-quality evidence to guide the decision to perform pathological analysis of tenosynovium, it is the opinion of the workgroup that this decision should be guided by patient preference and risk factors (Sood 2021).

Benefits/Harms of Implementation

The benefits of tenosynovial analysis include the possible detection and possible treatment of amyloidosis. The harms include the downstream care cascade that may result from a positive biopsy (e.g., lab testing, echocardiograms) that may be negative.

Cost Effectiveness/Resource Utilization

There are costs associated and resources utilized in the pathological analysis of tenosynovium. There are also downstream care cascades that may result from a positive sampling.

Acceptability

Accepted practice but may vary based upon risk factors and patient preference.

Feasibility

No feasibility issues beyond limitations in access to appropriate labs.

Future Research

Future research should involve the cost effectiveness of pathological analysis of tenosynovium based upon various risk profiles and the impact of downstream care cascades that may result from a positive sample.

POSTOPERATIVE PAIN: TRAMADOL

In the absence of reliable evidence, it is the opinion of the workgroup that Tramadol may be considered over other opioids for postoperative pain management.

Quality of Evidence: Very Low
Strength of Option: Consensus ★☆☆☆

Description: Evidence there is no supporting evidence, or limited level evidence was downgraded due to major concerns addressed in the EtD framework. In the absence of reliable evidence, the guideline work group is making a recommendation based on their clinical opinion.

Rationale

Miller et al. (2017) conducted a prospective cohort study to compare the effectiveness of opioids (i.e., hydrocodone, codeine, oxycodone) and tramadol. The results showed that patients that took opioids postoperatively had more medication-related side-effects and pill-consumption than those who took Tramadol. A multivariate regression analysis demonstrated that a tramadol prescription was an independent predictor of decreased total pill consumption. Moreover, patients with opioid prescriptions consumed only 28% of the filled prescription, compared to 36% consumption for tramadol. As this is the only article that met inclusion criteria and was low-quality due to its observational study design, the workgroup has provided the opinion consensus statement above.

Benefits/Harms of Implementation

The use of Tramadol over opioids for postoperative pain management has benefits as it avoids the many adverse effects of opioids (overdose and addiction).

Outcome Importance

Tramadol remains an option to help control postoperative pain.

Acceptability

Accepted treatment for pain in the postoperative state.

Future Research

There are no high-quality studies comparing the use of tramadol versus opioids in the control of postoperative pain after carpal tunnel release.

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APPENDICES

Appendix I: References

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Appendix II: PICO Questions Used to Define Literature Search

PICO Questions

1. In patients with symptoms and signs concerning for CTS, how can CTS be diagnosed?
2. Do occupations that involve keyboard typing or clerical work lead to increased development to CTS?
3. In patients presenting with CTS, do the selected non-operative treatments lead to improved outcomes in comparison to control or each other?
4. For patients undergoing surgical release for the treatment of CTS, what release techniques lead to better outcomes?
5. For patients undergoing surgical treatment for CTS, do outcomes differ between various modes of anesthesia?
6. For patients undergoing surgical treatment for CTS, do outcomes differ between Sites of Service?
7. For patients undergoing surgical treatment for CTS, does limited surgical draping lead to similar infection rates in comparison to full draping?
8. For patients undergoing surgical treatment for CTS, do various post-operative outcomes significantly differ between those who undergo continuation of anticoagulation prior to surgery and those without continuation of anticoagulation prior to surgery?
9. For patients undergoing surgical treatment for CTS, are there significant differences in infection rates or other complications between those treated with prophylactic antibiotics and those not treated with prophylactic antibiotics peri-operatively.
10. For patients who have been treated with a surgical intervention for CTS, is therapy indicated? If so, who, when, what (certain treatments), and how long (duration of therapy)?
11. For patients who have been treated with a surgical intervention for CTS, does post-operative immobilization result in significant differences in symptom relief and functional improvement, as compared to those who undergo early mobilization or unrestricted movement.
12. For patients undergoing surgical treatment for CTS, does preoperative testing (e.g., lab, EKG) influence or affect outcomes?
13. For patients undergoing surgical treatment for CTS, should patients have testing for amyloid?
14. For patients undergoing surgery for CTS, what postoperative pain management modalities lead to better PROs, complication rates?

Inclusion Criteria

To be included in our systematic reviews (and hence, in this guideline) an article had to meet the following criteria:

- Study must be of a CTS injury or prevention thereof.
- Study must be published in or after 1966 for surgical treatment, rehabilitation, bracing, prevention and MRI.
- Study must be published in or after 1966 for x rays and non-operative treatment.
- Study must be published in or after 1966 for all others non specified.
- Study should have 10 or more patients per group.
- For surgical treatment a minimum of 3 months follow up duration.
- Antibiotic prophylaxis, anti-coagulations, mode of anesthesia: all follow-ups
- For non-operative treatment a minimum of 1 month.

Standard Criteria for all CPGs

- The article must be a full article report of a clinical study.
- Retrospective non-comparative case series, medical records review, meeting abstracts, historical
- articles, editorials, letters, and commentaries are excluded.
- Confounded studies (i.e., studies that give patients the treatment of interest AND another treatment)
- are excluded.
- Case series studies that have non-consecutive enrollment of patients are excluded.
- Controlled trials in which patients were not stochastically assigned to groups AND in which there was either a difference in patient characteristics or outcomes at baseline AND where the authors did not statistically adjust for these differences when analyzing the results are excluded.
- All studies of "Very Low" Quality of evidence are excluded.
- All studies evaluated as Level V will be excluded.
- Composite measures or outcomes are excluded even if they are patient oriented.
- Study must appear in a peer-reviewed publication.
- For any included study that uses "paper-and-pencil" outcome measures (e.g., SF-36), only those outcome measures that have been validated will be included.
- For any given follow-up time point in any included study, there must be ≥ 50% patient follow-up (if the follow-up is >50% but <80%, the study quality will be downgraded by one Level)
- Study must be of humans.
- Study must be published in English.
- Study results must be quantitatively presented.
- Study must not be an in vitro study.
- Study must not be a biomechanical study.
- Study must not have been performed on cadavers.

*We will only evaluate surrogate outcomes when no patient-oriented outcomes are available.

Best Available Evidence

When examining primary studies, we will analyze the best available evidence regardless of study design. We will first consider randomized controlled trials identified by the search strategy. In the absence of two or more RCTs, we will sequentially search for prospective controlled trials, prospective comparative studies, retrospective comparative studies, and prospective case-series studies. Only studies of the highest level of available evidence are included, assuming that there were 2 or more 100 studies of that higher level. For example, if there are two Level II studies that address the recommendation, Level III and IV studies are not included.

We will only evaluate surrogate outcomes when no patient-oriented outcomes are available. We did not include systematic reviews or meta-analyses compiled by others or guidelines developed by other organizations. These documents are developed using different inclusion criteria than those specified by the AAOS work group. Therefore, they may include studies that do not meet our inclusion criteria. We recalled these documents, if the abstract suggested they might provide an answer to one of our recommendations and searched their bibliographies for additional studies to supplement our systematic review *2022 literature search for all PICOs will be performed from last search date of 2017 CPG.

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Appendix III: Literature Search Strategy

Database:	MEDLINE
Interface:	Ovid MEDLINE® and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions ® 1946 to March 22, 2022
Date of Initial Search:	3/23/2022
Date of Updated Search:	11/17/2022
Search	Carpal Tunnel 2022
Line	**Search Strategy**
1	English.lg.
2	(exp Animals/ NOT Humans/) OR exp Cadaver/ OR cadaver*.ti,ab. OR in-vitro.ti. OR ((comment OR editorial OR letter OR historical article) NOT clinical trial).pt. OR address.pt. OR news.pt. OR newspaper article.pt. OR pmcbook.af. OR case reports.pt. OR (case report? OR abstracts OR editorial OR reply OR comment? OR commentary OR letter).ti. OR (animal* OR dog OR dogs OR sheepdog OR canine OR cats OR feline OR horse* OR equine OR donkey* OR mice OR murin?e OR woodmouse OR rat OR rats OR cottonrat* OR rodent* OR hamster* OR squirrel* OR chipmunk* OR otter* OR weasel* OR badger* OR beaver* OR llama* OR alpaca* OR rabbit* OR hare OR hares OR sheep OR ovine OR lamb* OR goat* OR porcine OR swine* OR pig OR pigs OR piglet* OR boar OR boars OR hog OR hogs OR cow OR cows OR cattle* OR bull OR bulls OR bovine OR bison* OR buffalo* OR monkey* OR ape OR apes OR baboon* OR gibbon* OR bonobo* OR gorilla* OR lemur* OR chimp* OR orangutan* OR macaque* OR marmoset* OR primate* OR bear OR bears OR avian OR bird* OR hen OR hens OR duck? OR goose OR geese OR fowl? OR turkey* OR deer OR doe OR reindeer OR dolphin OR (fish* NOT fisher*) OR pisces OR trout* OR zebrafish* OR catfish* OR goldfish* OR seahorse* OR shark* OR salmon* OR whitefish* OR reptil* OR snake* OR lizard* OR alligator* OR crocodile* OR turtle* OR amphibian* OR frog* OR toad* OR eel? OR salamander* OR veterinar*).ti.
3	1 NOT 2
4	limit 3 to yr=2015-Current
5	Carpal-Tunnel-Syndrome/ OR ((carpal AND tunnel) OR ((median ADJ6 nerve?) AND (compression OR entrapment OR neuropath*)) OR (((compression OR entrapment OR median OR peripheral) AND neuropath*) AND (carpal OR wrist?))).ti,ab.
6	4 AND 5
7	Extracorporeal-Shockwave-Therapy/ OR Ultrasonic-Therapy/ OR (shockwave OR shock-wave OR ((ultraso* OR US) ADJ5 (therap* OR puls*)) OR hydrodissect* OR Graston).ti,ab. OR exp Stem-Cell-Transplantation/ OR exp Stem-Cells/ OR (stem-cell? OR autologous).ti,ab.
8	exp *Health-Facilities/ OR Ambulatory-Surgical-Procedures/ OR (clinic? OR (hospital AND cost)).ti. OR ((surgical OR surgery OR operat* OR clinic OR outpatient* OR inpatient* OR procedur* OR office) ADJ (room* OR setting* OR center* OR department* OR theatre*)).ti,ab.
9	Surgical-Drapes/ OR drap*.ti,ab.
10	((Preoperative-Care/ OR ((before OR pre?) ADJ6 (surg* OR procedur* OR operat* OR postoperative* OR release OR decompress*)).ti,ab.) AND (test* OR lab? OR laboratory OR evaluat* OR screen* OR study OR studies OR X-ray? OR assess* OR examination).ti,ab.) OR ((preoperative* OR pre-operative* OR presurg*) ADJ6 (test* OR lab? OR laboratory OR evaluat* OR screen* OR study OR studies OR X-ray? OR assess* OR examination)).ti,ab.
11	exp Amyloidosis/ OR (amyloid* OR TTR).ti,ab.
12	Pain-Postoperative/ OR Postoperative-Care/ OR exp Postoperative-Period/ OR (postoperative* OR post-operative* OR postsurg* OR post-surg* OR ((following OR after OR post) ADJ5 (surg* OR procedur* OR operat* OR release OR decompress*))).ti,ab.
13	Anesthesia/ OR exp Anesthesia-Conduction/ OR exp Anesthesia-General/ OR exp Anesthetics/ OR (an?esthesia OR an?esthetic? OR analgesi*).ti,ab. OR (lidocaine OR ropivacaine OR bupivacaine OR lignocaine).ti,ab.
14	Pain-Management/ OR (((multimodal* OR multi-modal*) AND (pain OR therapy)) OR (pain ADJ3 manag*)).ti,ab.
15	Acetaminophen/ OR (acetaminophen OR paracetamol OR Tylenol OR propacetamol).ti,ab.
16	exp Narcotics/ OR Tramadol/ OR (narcotic* OR opioid* OR opiate* OR papaver* OR oxycodone OR Oxycontin OR Oxy-ER OR Oxy-CRF OR OxyIR OR Oxy-IR OR Percodan OR Percocet OR Roxicet OR hydrocodone OR dihydrocodeinone OR Vicodin OR Vicoprofen OR Norco OR Lortab OR Lorcet OR oxymorphone OR Opana OR morphine OR Kadian OR Avinza OR MS Contin OR Duramorph OR Roxanol OR codeine OR fentanyl OR Duragesic OR Actiq OR Sublimaze OR hydromorphone OR Dilaudid OR meperidine OR Demerol OR tramadol OR Ultram OR buprenorphine OR propoxyphene OR Darvocet OR Omnopon OR methadone OR Dolophine OR Methadose OR suboxone OR nalbuphine OR propoxyphene OR pentazocine).ti,ab.
17	Pregabalin/ OR Gabapentin/ OR (gabapentin* OR Neurontin OR Gralise OR Horizant OR pregabalin OR Lyrica).ti,ab.

18	exp Anti-Inflammatory Agents, Non-Steroidal/ OR (NSAID* OR non-steroidal OR nonsteroidal OR meloxicam OR Mobic OR naproxen OR Aleve OR ibuprofen OR Advil OR flurbiprofen OR ketorolac OR Toradol OR COX-2-inhibitor* OR COX2-inhibitor* OR celecoxib OR Celebrex OR diclofenac OR misoprostol OR sulindac OR ketoprofen OR tolmetin OR etodolac OR fenoprofen OR piroxicam OR indomethacin OR nabumetone OR aspirin).ti,ab.
19	exp Adrenal-Cortex-Hormones/ OR (corticosteroid* OR (steroid* NOT (non-steroid*)) OR corticoid* OR prednisone OR prednisolone OR methylprednisolone OR triamcinolone OR dexamethasone OR glucocorticoid*).tw.
20	6 OR (3 AND 5 AND (7 OR 8 OR 9 OR 10 OR 11 OR (12 AND (13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19))))

View background material via the CPG eAppendix 1
View data summaries via the CPG eAppendix 2

Database:	Embase
Interface:	Elsevier
Date of Initial Search:	3/23/2022
Date of Updated Search	11/17/2022
Search	Carpal Tunnel 2022
Query #	**Search**
1	[english]/lim
2	abstract-report/de OR book/de OR editorial/de OR editorial:it OR note/de OR note:it OR letter/de OR letter:it OR case-study/de OR case-report/de OR chapter:it OR conference-paper/exp OR conference-paper:it OR conference-abstract:it OR conference-review:it OR (abstracts OR editorial OR reply OR comment$ OR commentary OR letter):ti OR cadaver/de OR in-vitro-study/exp OR cadaver*:ti,ab OR in-vitro:ti OR animal-experiment/exp OR (animal* OR dog OR dogs OR sheepdog OR canine OR cats OR feline OR horse* OR equine OR donkey* OR mice OR murin$e OR woodmouse OR rat OR rats OR cottonrat* OR rodent* OR hamster* OR squirrel* OR chipmunk* OR otter* OR weasel* OR badger* OR beaver* OR llama* OR alpaca* OR rabbit* OR hare OR hares OR sheep OR ovine OR lamb* OR goat* OR porcine OR swine* OR pig OR pigs OR piglet* OR boar OR boars OR hog OR hogs OR cow OR cows OR cattle* OR bull OR bulls OR bovine OR bison* OR buffalo* OR monkey* OR ape OR apes OR baboon* OR gibbon* OR bonobo* OR gorilla* OR lemur* OR chimp* OR orangutan* OR macaque* OR marmoset* OR primate* OR bear OR bears OR avian OR bird* OR hen OR hens OR duck$ OR goose OR geese OR fowl$ OR turkey* OR deer OR doe OR reindeer OR dolphin OR (fish* NOT fisher*) OR pisces OR trout* OR zebrafish* OR catfish* OR goldfish* OR seahorse* OR shark* OR salmon* OR whitefish* OR reptil* OR snake* OR lizard* OR alligator* OR crocodile* OR turtle* OR amphibian* OR frog* OR toad* OR eel$ OR salamander* OR veterinar*):ti
3	#1 NOT #2 AND [2015-3000]/py
4	carpal-tunnel-syndrome/de OR ((carpal AND tunnel) OR ((median ADJ6 nerve$) AND (compression OR entrapment OR neuropath*)) OR (((compression OR entrapment OR median OR peripheral) AND neuropath*) AND (carpal OR wrist?))):ti,ab
5	#3 AND #4
6	((#1 AND #4) NOT #2)
7	shock-wave-therapy/de OR extracorporeal-shock-wave-lithotripsy/de OR ultrasound-therapy/exp OR (shockwave OR shock-wave OR ((ultraso* OR US) NEAR/5 (therap* OR puls*)) OR hydrodissect* OR Graston):ti,ab OR stem-cell-transplantation/exp OR stem-cell/exp OR (stem-cell* OR autologous):ti,ab
8	health-care-facility/exp/mj OR (clinic$ OR (hospital AND cost)):ti OR ((surgical OR surgery OR operat* OR clinic OR outpatient* OR inpatient* OR procedur* OR office) NEXT/1 (room* OR setting* OR center* OR department* OR theatre*)):ti,ab
9	surgical-drape/exp OR drap*:ti,ab
10	((preoperative-care/de OR ((before OR pre$) NEXT/6 (surg* OR procedur* OR operat* OR postoperative* OR release OR decompress*)):ti,ab) AND (test* OR lab$ OR laboratory OR evaluat* OR screen* OR study OR studies OR X-ray* OR assess* OR examination):ti,ab) OR ((preoperative* OR pre-operative* OR presurg*) NEAR/6 (test* OR lab? OR laboratory OR evaluat* OR screen* OR study OR studies OR X-ray* OR assess* OR examination)):ti,ab
11	amyloidosis/exp OR (amyloid* OR TTR):ti,ab
12	postoperative-pain/de OR postoperative-period/exp OR (postoperative* OR post-operative* OR postsurg* OR post-surg* OR ((following OR after OR post) NEXT/5 (surg* OR procedur* OR operat* OR release OR decompress*))):ti,ab
13	anesthesia/de OR general-anesthesia/exp OR regional-anesthesia/exp OR local-anesthesia/exp OR anesthetic-agent/exp OR local-anesthetic-agent/exp OR analgesia/exp OR analgesic-agent/exp OR (an$esthesia OR an$esthetic$ OR analgesi*):ti,ab OR (lidocaine OR ropivacaine OR bupivacaine OR lignocaine):ti,ab
14	(((multimodal* OR multi-modal*) AND (pain OR therapy)) OR (pain ADJ3 manag*)):ti,ab
15	paracetamol/exp OR propacetamol/exp OR (acetaminophen OR paracetamol OR propacetamol OR tylenol):ti,ab

16	narcotic-agent/exp OR narcotic-analgesic-agent/exp OR (narcotic* OR opioid* OR opiate* OR papaver* OR oxycodone OR Oxycontin OR Oxy-ER OR Oxy-CRF OR OxyIR OR Oxy-IR OR Percodan OR Percocet OR Roxicet OR hydrocodone OR dihydrocodeinone OR Vicodin OR Vicoprofen OR Norco OR Lortab OR Lorcet OR oxymorphone OR Opana OR morphine OR Kadian OR Avinza OR MS-Contin OR Duramorph OR Roxanol OR codeine OR fentanyl OR Duragesic OR Actiq OR Sublimaze OR hydromorphone OR Dilaudid OR meperidine OR Demerol OR tramadol OR Ultram OR buprenorphine OR propoxyphene OR Darvocet OR Omnopon OR methadone OR Dolophine OR Methadose OR suboxone OR nalbuphine OR propoxyphene OR pentazocine):ti,ab
17	pregabalin/exp OR gabapentinoid/exp OR gabapentin/exp OR (pregabalin OR gabapentin* OR Lyrica OR Neurontin OR Gralise OR Horizant):ti,ab
18	nonsteroid-antiinflammatory-agent/exp OR cyclooxygenase-2-inhibitor/exp OR (NSAID* OR non-steroidal OR nonsteroidal OR meloxicam OR mobic OR naproxen OR aleve OR ibuprofen OR advil OR flurbiprofen OR ketorolac OR toradol OR cox-2-inhibitor* OR cox2-inhibitor* OR celecoxib OR celebrex OR diclofenac OR misoprostol OR sulindac OR ketoprofen OR tolmetin OR fenoprofen OR piroxicam OR etodolac OR indomethacin OR nabumetone OR aspirin):ti,ab
19	corticosteroid/exp OR (corticosteroid* OR (steroid* NOT (non-steroid*)) OR corticoid* OR prednisone OR prednisolone OR methylprednisolone OR triamcinolone OR dexamethasone OR glucocorticoid*):ti,ab
20	#5 OR (#6 AND (#7 OR #8 OR #9 OR #10 OR #11 OR (#12 AND (#13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19))))

View background material via the CPG eAppendix 1
View data summaries via the CPG eAppendix 2

Database:	Cochrane Central Register of Controlled Trials (CENTRAL)
Interface:	Wiley (https://www.cochranelibrary.com/central)
Date of Initial Search:	3/23/2022
Date of Updated Search:	11/17/2022
Search	Carpal Tunnel 2022
Query #	**Search**
1	((carpal AND tunnel) OR ((median NEAR/6 nerve$) AND (compression OR entrapment OR neuropath*)) OR (((compression OR entrapment OR median OR peripheral) AND neuropath*) AND (carpal OR wrist?))):ti,ab
2	"conference abstract":pt OR (abstracts OR editorial OR reply OR comment? OR commentary OR letter OR biomechanic*):ti OR cadaver*:ti,ab OR "in vitro":ti OR (animal* OR dog OR dogs OR sheepdog OR canine OR cats OR feline OR horse* OR equine OR donkey* OR mice OR murin?e OR woodmouse OR rat OR rats OR cottonrat* OR rodent* OR hamster* OR squirrel* OR chipmunk* OR otter* OR weasel* OR badger* OR beaver* OR llama* OR alpaca* OR rabbit* OR hare OR hares OR sheep OR ovine OR lamb* OR goat* OR porcine OR **swine*** OR pig OR pigs OR piglet* OR boar OR boars OR hog OR hogs OR cow OR cows OR cattle* OR bull OR bulls OR bovine OR bison* OR buffalo* OR monkey* OR ape OR apes OR baboon* OR gibbon* OR bonobo* OR gorilla* OR lemur* OR chimp* OR orangutan* OR macaque* OR marmoset* OR primate* OR bear OR bears OR **avian OR bird*** OR hen OR hens OR duck? OR goose OR geese OR fowl? OR turkey* OR deer OR doe OR reindeer OR dolphin OR (fish* NOT fisher*) OR pisces OR trout* OR zebrafish* OR catfish* OR goldfish* OR seahorse* OR shark* OR salmon* OR whitefish* OR reptil* OR snake* OR lizard* OR alligator* OR crocodile* OR turtle* OR amphibian* OR frog* OR toad* OR eel? OR salamander* OR veterinar*):ti
3	#1 NOT #2 *with Publication Year from 2015 to 2022, in Trials*
4	#1 NOT #2 *with Cochrane Library publication date from Feb 2015 to Mar 2022, in Cochrane Reviews*
5	#3 OR #4
6	(shockwave OR shock-wave OR ((ultraso* OR US) NEAR/5 (therap* OR puls*)) OR hydrodissect* OR Graston):ti,ab OR (stem-cell$ OR autologous):ti,ab
7	(clinic? OR (hospital AND cost)):ti OR ((surgical OR surgery OR operat* OR clinic OR outpatient* OR inpatient* OR procedur* OR office) NEXT/1 (room* OR setting* OR center* OR department* OR theatre*)):ti,ab
8	drap*:ti,ab
9	(((before OR pre?) NEXT/6 (surg* OR procedur* OR operat* OR postoperative* OR release OR decompress*)):ti,ab AND (test* OR lab? OR laboratory OR evaluat* OR screen* OR study OR studies OR X-ray? OR assess* OR examination):ti,ab) OR ((preoperative* OR pre-operative* OR presurg*) NEAR/6 (test* OR lab? OR laboratory OR evaluat* OR screen* OR study OR studies OR X-ray? OR assess* OR examination)):ti,ab
10	(amyloid* OR TTR):ti,ab
11	(postoperative* OR post-operative* OR postsurg* OR post-surg* OR ((following OR after OR post) NEXT/5 (surg* OR procedur* OR operat* OR release OR decompress*))):ti,ab
12	(an$esthesia OR an$esthetic$ OR analgesi*):ti,ab OR (lidocaine OR ropivacaine OR bupivacaine OR lignocaine):ti,ab
13	(((multimodal* OR multi-modal*) AND (pain OR therapy)) OR (pain NEAR/3 manag*)):ti,ab
14	(acetaminophen OR paracetamol OR propacetamol OR tylenol):ti,ab
15	(narcotic* OR opioid* OR opiate* OR papaver* OR oxycodone OR Oxycontin OR Oxy-ER OR Oxy-CRF OR OxyIR OR Oxy-IR OR Percodan OR Percocet OR Roxicet OR hydrocodone OR dihydrocodeinone OR Vicodin OR Vicoprofen OR Norco OR Lortab OR Lorcet OR oxymorphone OR Opana OR morphine OR Kadian OR Avinza OR MS-Contin OR Duramorph OR Roxanol OR codeine OR fentanyl OR Duragesic OR Actiq OR Sublimaze OR hydromorphone OR Dilaudid OR meperidine OR Demerol OR tramadol OR Ultram OR buprenorphine OR propoxyphene OR Darvocet OR Omnopon OR methadone OR Dolophine OR Methadose OR suboxone OR nalbuphine OR propoxyphene OR pentazocine):ti,ab
16	(pregabalin OR gabapentin* OR Lyrica OR Neurontin OR Gralise OR Horizant):ti,ab

17	(NSAID* OR non-steroidal OR nonsteroidal OR meloxicam OR mobic OR naproxen OR aleve OR ibuprofen OR advil OR flurbiprofen OR ketorolac OR toradol OR ((cox-2 OR cox2) NEXT/1 inhibitor*) OR celecoxib OR celebrex OR diclofenac OR misoprostol OR sulindac OR ketoprofen OR tolmetin OR fenoprofen OR piroxicam OR etodolac OR indomethacin OR nabumetone OR aspirin):ti,ab
18	(corticosteroid* OR (steroid* NOT (non-steroid*)) OR corticoid* OR adrenal-cortex-hormone* OR prednisone OR methylprednisolone OR triamcinolone OR glucocorticoid* OR cortisone OR hydrocortisone OR dexamethasone OR prednisolone OR betamethasone OR budesonide OR mineralocorticoid*):ti,ab
19	#1 NOT #2
20	#5 OR (#19 AND (#6 OR #7 OR #8 OR #9 OR #10 OR (#11 AND (#12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18))))

View background material via the CPG eAppendix 1
View data summaries via the CPG eAppendix 2

Appendix IV: Guideline Development Group Disclosures

Prior to the development of this clinical practice guideline, clinical practice guideline development group members disclose conflicts of interest (COI). They disclose COIs in writing to the American Academy of Orthopaedic Surgeons via a private on-line reporting database and also verbally at the recommendation approval meeting.

Robin Neil Kamal, MD, FAAOS
AAOS: Board or committee member ($0) EBQV(Self)
Acumed, LLC: Paid consultant ($30,000) general consulting(Self)
American Society for Surgery of the Hand: Board or committee member ($0) Quality Metrics Committee (Self)

Lauren Michelle Shapiro, MD
(This individual reported nothing to disclose)

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(This individual reported nothing to disclose)

Jason Strelzow, MD, FAAOS
Acumed, LLC: Paid presenter or speaker ($2,000) Number of Presentations: 2 Acumed(Self)
Acumed, LLC: Paid consultant ($9,000) Consulting Services(Self)
American Society for Surgery of the Hand: Board or committee member ($0) N/A(Self)
BoneSupport: Paid presenter or speaker ($2,500) Number of Presentations: 2 N/A(Self)
BoneSupport: Paid consultant ($2,000) BoneSupport(Self)
Journal of Bone and Joint Surgery - American: Editorial or governing board ($0) JBJS Reviews(Self)
Journal of Hand Surgery - American: Editorial or governing board ($0) N/A(Self)
Orthopaedic Trauma Association: Board or committee member ($0) N/A(Self)
Stryker: Other financial or material support ($300) N/A(Self)

Mia Erickson, PT
American Physical Therapy Association: Board or committee member ($0) Board of Directors(Self)
SLACK Incorporated: Publishing royalties, financial or material support ($7,000) I have published 2 textbooks on physical therapy documentation for SLACK inc. and I am a consultant for a book series for the physical therapist assistant(Self)

Karen Chi-Lynn Chen, MD
(This individual reported nothing to disclose)

Jeff Steven Brault, DO
American Academy for Cerebral Palsy and Developmental Medicine: Board or committee member ($0) Wife on Board for this group (Family)

Douglas W Martin, MD
ACOEM Practice Guidelines: Editorial or governing board ($0) I serve on the Disability Evaluation Chapter Panel(Self)
American College of Occupational & Environmental Medicine: Board or committee member ($0) President Elect - will be President in May 2022(Self)
Interstate Postgraduate Medical Association: Board or committee member ($0) Vice Chair(Self)
Iowa Academy of Family Physicians: Board or committee member ($0) Board of Directors(Self)
ODG Treatment in Workers Compensation: Editorial or governing board ($0) I serve on the Editorial Advisory Board(Self)

Mohammad Kian Salajegheh, MD
(This individual reported nothing to disclose)

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American Association for Hand Surgery: Board or committee member ($0)
Journal of Hand Surgery - American: Editorial or governing board ($0)

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