AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

THE TREATMENT OF DISTAL RADIUS FRACTURES

GUIDELINE AND EVIDENCE REPORT

Adopted by the American Academy of Orthopaedic Surgeons Board of Directors
December 5, 2009

Disclaimer
This Clinical Practice Guideline was developed by an AAOS physician volunteer Work Group based on a systematic review of the current 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 clinical circumstances.

Disclosure Requirement
In accordance with AAOS policy, all individuals whose names appear as authors or contributors to 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 Guidelines.

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The Treatment of Distal Radius Fractures

Summary of Recommendations

The following is a summary of the recommendations in the AAOS' clinical practice guideline, The Treatment of Distal Radius Fractures. The scope of this guideline is specifically limited to acute distal radius fractures. This summary does not contain rationales that explain how and why these recommendations were developed nor does it contain the evidence supporting these recommendations. All readers of this summary are strongly urged to consult the full guideline and evidence report for this information. We are confident that those who read the full guideline and evidence report will see that the recommendations were developed using systematic evidence-based processes designed to combat bias, enhance transparency, and promote reproducibility.

This summary of recommendations is not intended to stand alone. Treatment decisions should be made in light of all circumstances presented by the patient. Treatments and procedures applicable to the individual patient rely on mutual communication between patient, physician, and other healthcare practitioners.

Please refer to the sections titled Judging the Quality of Evidence and Defining the Strength of the Recommendations for a detailed description of the link between the evidence supporting the strength of a recommendation and the language used in the guideline.

1. We are unable to recommend for or against performing nerve decompression when nerve dysfunction persists after reduction.

   Strength of Recommendation: Inconclusive

   Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

   Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

2. We are unable to recommend for or against casting as definitive treatment for unstable fractures that are initially adequately reduced.

   Strength of Recommendation: Inconclusive

   Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

   Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

3. We suggest operative fixation for fractures with post-reduction radial shortening >3mm, dorsal tilt >10 degrees, or intra-articular displacement or step-off >2mm as opposed to cast fixation.

   Strength of Recommendation: Moderate

   Description: Evidence from two or more "Moderate" strength studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.

   Implications: Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.

4. We are unable to recommend for or against any one specific operative method for fixation of distal radius fractures.

   Strength of Recommendation: Inconclusive

   Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

   Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

5. We are unable to recommend for or against operative treatment for patients over age 55 with distal radius fractures.

   Strength of Recommendation: Inconclusive

   Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

   Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

6. We are unable to recommend for or against locking plates in patients over the age of 55 who are treated operatively.

   Strength of Recommendation: Inconclusive

   Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

   Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

7. We suggest rigid immobilization in preference to removable splints when using non-operative treatment for the management of displaced distal radius fractures.

   Strength of Recommendation: Moderate

   Description: Evidence from two or more “Moderate” strength studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.

   Implications: Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.

8. The use of removable splints is an option when treating minimally displaced distal radius fractures.

   Strength of Recommendation: Limited

   Description: Evidence from two or more “Low” strength studies with consistent findings, or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

   Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

9. We are unable to recommend for or against immobilization of the elbow in patients treated with cast immobilization.

   Strength of Recommendation: Inconclusive

   Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

   Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

10. Arthroscopic evaluation of the articular surface is an option during operative treatment of intra-articular distal radius fractures.

    Strength of Recommendation: Limited

    Description: Evidence from two or more “Low” strength studies with consistent findings, or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

    Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

11. Operative treatment of associated ligament injuries (SLIL injuries, LT, or TFCC tears) at the time of radius fixation is an option.

    Strength of Recommendation: Limited

    Description: Evidence from two or more “Low” strength studies with consistent findings, or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

    Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

12. Arthroscopy is an option in patients with distal radius intra articular fractures to improve diagnostic accuracy for wrist ligament injuries, and CT is an option to improve diagnostic accuracy for patterns of intra-articular fractures.

    Strength of Recommendation: Limited

    Description: Evidence from two or more “Low” strength studies with consistent findings, or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

    Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

13. We are unable to recommend for or against the use of supplemental bone grafts or substitutes when using locking plates.

    Strength of Recommendation: Inconclusive

    Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

    Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

14. We are unable to recommend for or against the use of bone graft (autograft or allograft) or bone graft substitutes for the filling of a bone void as an adjunct to other operative treatments.

    Strength of Recommendation: Inconclusive

    Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

    Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

15. In the absence of reliable evidence, it is the opinion of the work group that distal radius fractures that are treated non-operatively be followed by ongoing radiographic evaluation for 3 weeks and at cessation of immobilization.

    Strength of Recommendation: Consensus

    Description: The supporting evidence is lacking and requires the work group to make a recommendation based on expert opinion by considering the known potential harm and benefits associated with the treatment. A **Consensus** recommendation means that expert opinion supports the guideline recommendation even though there is no available empirical evidence that meets the inclusion criteria of the guideline's systematic review.

    Implications: Practitioners should be flexible in deciding whether to follow a recommendation classified as **Consensus,** although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.

16. We are unable to recommend whether two or three Kirschner wires should be used for distal radius fracture fixation.

    Strength of Recommendation: Inconclusive

    Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

    Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

17. We are unable to recommend for or against using the occurrence of distal radius fractures to predict future fragility fractures.

    Strength of Recommendation: Inconclusive

    Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

    Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

18. We are unable to recommend for or against concurrent surgical treatment of distal radioulnar joint instability in patients with operatively treated distal radius fractures.

    Strength of Recommendation: Inconclusive

    Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

    Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

19. We suggest that all patients with distal radius fractures receive a post-reduction true lateral x-ray of the carpus to assess DRUJ alignment.

    Strength of Recommendation: Moderate

    Description: Evidence from two or more “Moderate” strength studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.

    Implications: Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.

20. In the absence of reliable evidence, it is the opinion of the work group that all patients with distal radius fractures and unremitting pain during follow-up be re-evaluated.

    Strength of Recommendation: Consensus

    Description: The supporting evidence is lacking and requires the work group to make a recommendation based on expert opinion by considering the known potential harm and benefits associated with the treatment. A **Consensus** recommendation means that expert opinion supports the guideline recommendation even though there is no available empirical evidence that meets the inclusion criteria of the guideline's systematic review.

    Implications: Practitioners should be flexible in deciding whether to follow a recommendation classified as **Consensus,** although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.

21. A home exercise program is an option for patients prescribed therapy after distal radius fracture.

    Strength of Recommendation: Limited

    Description: Evidence from two or more "Low" strength studies with consistent findings, or evidence from a single "Moderate" quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

    Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

22. In the absence of reliable evidence, it is the opinion of the work group that patients perform active finger motion exercises following diagnosis of distal radius fractures.

    Strength of Recommendation: Consensus

    Description: The supporting evidence is lacking and requires the work group to make a recommendation based on expert opinion by considering the known potential harm and benefits associated with the treatment. A **Consensus** recommendation means that expert opinion supports the guideline recommendation even though there is no available empirical evidence that meets the inclusion criteria of the guideline's systematic review.

    Implications: Practitioners should be flexible in deciding whether to follow a recommendation classified as **Consensus,** although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.

23. We suggest that patients do not need to begin early wrist motion routinely following stable fracture fixation.

    Strength of Recommendation: Moderate

    Description: Evidence from two or more “Moderate” strength studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention. A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.

    Implications: Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.

24. In order to limit complications when using external fixation, it is an option to limit the duration of fixation.

    Strength of Recommendation: Limited

    Description: Evidence from two or more “Low” strength studies with consistent findings, or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

    Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

25. We are unable to recommend for or against over-distraction of the wrist when using an external fixator.

    Strength of Recommendation: Inconclusive

    Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

    Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

26. We suggest adjuvant treatment of distal radius fractures with Vitamin C for the prevention of disproportionate pain.

    Strength of Recommendation: Moderate

    Description: Evidence from two or more “Moderate” strength studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention. A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.

    Implications: Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.

27. Ultrasound and/or ice are options for adjuvant treatment of distal radius fractures.

    Strength of Recommendation: Limited

    Description: Evidence from two or more “Low” strength studies with consistent findings, or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

    Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

28. We are unable to recommend for or against fixation of ulnar styloid fractures associated with distal radius fractures.

    Strength of Recommendation: Inconclusive

    Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

    Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

29. We are unable to recommend for or against using external fixation alone for the management of distal radius fractures where there is depressed lunate fossa or 4-part fracture (sagittal split).

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

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I. INTRODUCTION

OVERVIEW

This clinical practice guideline is based on a systematic review of published studies on the treatment of distal radius fractures in adults. This guideline scope is limited to the treatment of acute distal radius fractures. In addition to providing practice recommendations, this guideline also highlights gaps in the literature and areas that require future research.

This guideline is intended to be used by all appropriately trained surgeons and all qualified physicians managing the treatment of distal radius fractures. It is also intended to serve as an information resource for professional healthcare practitioners and developers of practice guidelines and recommendations.

GOALS AND RATIONALE

The purpose of this clinical practice guideline is to help improve treatment based on the current best evidence. Current evidence-based medicine (EBM) standards demand that physicians use the best available evidence in their clinical decision making. To assist in this, this clinical practice guideline consists of a systematic review of the available literature regarding the treatment of distal radius fractures. The systematic review detailed herein was conducted between July 2008 and June 2009 and demonstrates where there is good evidence, where evidence is lacking, and what topics future research must target in order to improve the treatment of patients with acute distal radius fractures. AAOS staff and the physician work group systematically reviewed the available literature and subsequently wrote the following recommendations based on a rigorous, standardized process.

Musculoskeletal care is provided in many different settings by many different providers. We created this guideline as an educational tool to guide qualified physicians through a series of treatment decisions in an effort to improve the quality and efficiency of care. This guideline is not to be construed as including all proper methods of care or excluding methods of care reasonably directed to obtaining the same results. The ultimate judgment regarding any specific procedure or treatment includes consideration of all circumstances presented by the patient and the needs and resources particular to the locality or institution.

INTENDED USERS

This guideline is intended to be used by orthopaedic surgeons and all qualified physicians managing patients with acute fracture of the distal radius. Typically, orthopaedic surgeons will have completed medical training, a qualified residency in orthopaedic surgery, and some may have completed additional sub-specialty training. It is also intended to serve as an information resource for professional healthcare practitioners and developers of practice guidelines and recommendations.

Treatment for acute fracture of the distal radius is based on the assumption that decisions are predicated on patient and physician mutual communication with discussion of available treatments and procedures applicable to the individual patient. Once the patient has been informed of available therapies and has discussed these options with his/her physician, an informed decision can be made. Clinician input based on experience with both conservative management and surgical skills increases the probability of identifying patients who will benefit from specific treatment options.

PATIENT POPULATION

This document addresses the treatment of acute distal radius fracture in adults (defined as patients 19 years of age and older).

ETIOLOGY

Fracture of the distal radius is the result of trauma. There is a bimodal distribution of distal radius fractures where high-energy fractures occur in younger persons (predominately male) and high and low-energy fractures occur in older persons (predominately female).[1, 2]

INCIDENCE

Distal radius fracture is on of the most common fractures seen by orthopaedic surgeons with an incidence of 195.2/100,000 persons per year.[2]

BURDEN OF DISEASE

As one of the most common fractures seen by orthopaedic surgeons, distal radius fractures result in significant financial burden. Costs related to distal radius fracture are mostly service related and at least $164,000,000 was spent on hospitalizations related to distal radius fracture in 2007. [3, 4]

EMOTIONAL AND PHYSICAL IMPACT

Acute distal radius fracture results in pain, tenderness, swelling and potential deformity. Patients may be faced with substantial morbidity if fracture healing is delayed or results in clinically significant deformity. Additionally, there are known complications in the treatment of distal radius fracture. The recovery period for distal radius fracture can be substantial and the impact of the method of fixation on activities and daily living can be significant.

POTENTIAL BENEFITS, HARMS, AND CONTRAINDICATIONS

The aim of treatment is pain relief and maintenance of the patient's functional status. Most treatments are associated with some known risks, especially invasive and operative treatments. In addition, contraindications vary widely based on the treatment administered. Therefore, discussion of available treatments and procedures applicable to the individual patient rely on mutual communication between the patient and physician, weighing the potential risks and benefits for that patient.

II. **METHODS**

This clinical practice guideline and the systematic review upon which it is based evaluate the effectiveness of treatments for acute distal radius fractures. This section describes the methods used to prepare this guideline and systematic review, including search strategies used to identify literature, criteria for selecting eligible articles, determining the strength of the evidence, data extraction, methods of statistical analysis, and the review and approval of the guideline. The methods used to perform this systematic review were employed to minimize bias in the selection, appraisal, and analysis of the available evidence.[5, 6] These processes are vital to the development of reliable, transparent, and accurate clinical recommendations for treating acute distal radius fractures.

This guideline and systematic review were prepared by the AAOS Treatment of Acute Distal Radius Fractures guideline work group with the assistance of the AAOS Clinical Practice Guidelines Unit in the Department of Research and Scientific Affairs at the AAOS (Appendix I).

To develop this guideline, the work group held an introductory meeting to develop the scope of the guideline on July 17 and 18, 2008. Upon completion of the systematic review, the work group met again on July 18 and 19, 2009 to write and vote on the final recommendations and rationales for each recommendation. The resulting draft guidelines were then peer-reviewed, subsequently sent for public commentary, and then sequentially approved by the AAOS Evidence Based Practice Committee, AAOS Guidelines and Technology Oversight Committee, AAOS Council on Research, Quality Assessment, and Technology, and the AAOS Board of Directors (see Appendix II for a description of the AAOS bodies involved in the approval process)

FORMULATING PRELIMINARY RECOMMENDATIONS

The work group began work on this guideline by constructing a set of preliminary recommendations. These recommendations specify [what] will be done in [whom], [when], [where], and [how often or how long]. They function as questions for the systematic review, not as final recommendations or conclusions. Preliminary recommendations are almost always modified on the basis of the results of the systematic review. Once established, these *a priori* preliminary recommendations cannot be modified until the final work group meeting, they must be addressed by the systematic review, and the relevant review results must be presented in the final guideline.

STUDY SELECTION CRITERIA

We developed *a priori* article inclusion criteria for our review. These criteria are our "rules of evidence" and articles that do not meet them are, for the purposes of this guideline, not evidence.

To be included in our systematic reviews (and hence, in this guideline) an article had to be a report of a study that:

- Evaluated a treatment for acute distal radius fracture; studies of non unions, malunions, delayed unions, or osteotomies are excluded

- Was a full report of a clinical study and was published in the peer reviewed literature

- Was an English language article published after 1965

- Was not a cadaveric, animal, *in vitro,* or biomechanical

- Was not a retrospective case series, medical records review, meeting abstract, unpublished study report, case report, historical article, editorial, letter, or commentary

- Was the most recent report of a study or the report with the largest number of enrolled patients in a study with multiple publications

- Enrolled ≥ 10 patients in each of its study groups

- For adverse events or complications, the studies must have groups with 25 or more patients

- Enrolled a patient population comprised of at least 80% of patients 19 years of age or older

- Reports quantified results

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

OUTCOMES CONSIDERED

Clinical studies often report many different outcomes. For this guideline, only patient-oriented outcomes are included, and surrogate/intermediate outcomes are not considered. Surrogate outcome measures are laboratory measurements or another physical sign used as substitutes for a clinically meaningful end point that measures directly how a patient feels, functions, or survives.[7] Radiographic results are an example of a surrogate outcome.

For outcomes measured using “paper and pencil” instruments (e.g. the visual analogue scale, the Disabilities of the Arm, Shoulder, and Hand, Patient-Rated Wrist Evaluation), the results using validated instruments are considered the best available evidence. In the absence of results using validated instruments, results using non-validated instruments (e.g. Gartland and Werley score) are considered as the best available evidence and the strength of the recommendation is lowered.

MINIMAL CLINICALLY IMPORTANT IMPROVEMENT

Wherever possible, we considered the effects of treatments in terms of the minimal clinically important improvement (MCII) in addition to whether their effects were statistically significant. The MCII is the smallest clinical change that is important to patients, and recognizes the fact that there are some treatment-induced statistically significant improvements that are too small to matter to patients. The values we used for MCIIs are derived from a published study investigating the Disabilities of the Arm Shoulder and Hand (DASH); Patient-Rated Wrist Evaluation (PRWE), and the Medical Outcomes Study 12-Item Short-Form Health Survey, Physical Component Scale (SF-12 PCS).[8] To calculate the standardized MCII, we divided the reported minimal clinically important difference (MCID) between baseline and follow-up scores by the standard deviation of the mean baseline score.

Table 1 MCII of outcomes

Outcome Measure	MCII (points)	MCII (standardized)
DASH	17.1	0.99
PRWE	24.0	1.40
SF-12 PCS	7.3	0.94

When possible we describe the results of studies using terminology based on that of Armitage, et al.[9] The associated descriptive terms in this guideline and the conditions for using each of these terms, are outlined in the following table:

Table 2 Descriptive terms for results with MCII

Descriptive Term	Condition for Use
Clinically Important	Statistically significant and lower confidence limit > MCII
Possibly Clinically Important	Statistically significant and confidence intervals contain the MCII
Not Clinically Important	Statistically significant and upper confidence limit < MCII
Negative	Not statistically significant and upper confidence limit < MCII
Inconclusive	Not statistically significant but confidence intervals contain the MCII

LITERATURE SEARCHES

We attempted to make our searches for articles comprehensive. Using comprehensive literature searches ensures that the evidence we considered for this guideline is not biased for (or against) any particular point of view.

We searched for articles published from January 1966 to June 1, 2009. Strategies for searching electronic databases were constructed by a Medical Librarian using previously published search strategies [10, 11] to identify relevant randomized controlled trials (RCTs). In the absence of relevant RCTs, the Medical Librarian modified the search strategy to identify studies of other designs. We searched four electronic databases; PubMed, EMBASE, CINAHL, and The Cochrane Central Register of Controlled Trials.

We supplemented searches of electronic databases with manual screening of the bibliographies of all retrieved publications. We also searched the bibliographies of recent systematic reviews and other review articles for potentially relevant citations. Finally, work group members provided a list of potentially relevant studies that were not identified by our searches. All articles identified were subject to the study selection criteria listed above.

The study attrition diagram in Appendix III provides details about the inclusion and exclusion of the studies considered for this guideline. The search strategies used to identify these studies are provided in Appendix IV.

DATA EXTRACTION

Data elements extracted from studies were defined in consultation with the physician work group. A research analyst completed data extraction independently for all studies. The elements extracted are shown in Appendix V. Evidence tables were constructed to summarize the best evidence pertaining to each preliminary recommendation. Disagreements about the accuracy of extracted data were resolved by consensus and consulting the work group. Disagreements were resolved by consensus and by consulting the physician work group.

Evidence tables are available as a supplemental document available on the AAOS website http://www.aaos.org/research/guidelines/guide.asp. These evidence tables include complete lists of included and excluded articles, quality and design parameters of the included studies, and raw data extracted from the included studies.

JUDGING THE QUALITY OF EVIDENCE

Determining the quality of the included evidence is vitally important when preparing any evidence-based work product. Doing so conveys the amount of confidence one can have in any study’s results. One has more confidence in high quality evidence than in low quality evidence.

Assigning a level of evidence on the basis of study design plus other quality characteristics ties the levels of evidence we report more closely to quality than levels of evidence based only on study design. Because we tie quality to levels of evidence, we are able to characterize the confidence one can have in their results. Accordingly, we characterize the confidence one can have in Level I evidence as high, the confidence one can have in Level II and III evidence as moderate, and the confidence one can have in Level IV and V evidence as low.

TREATMENT STUDIES

In studies investigating the result of treatment, we assessed the quality of the evidence for each outcome at each time point reported in a study. We did not simply assess the overall quality of a study. Our approach follows the recommendations of the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) working group[12] as well as others.[13]

We evaluated quality on a per outcome basis rather than a per study basis because quality is not necessarily the same for all outcomes and all follow-up times reported in a study. For example, a study might report results immediately after patients received a given treatment and after some period of time has passed. Often, nearly all enrolled patients contribute data at early follow-up times but, at much later follow-up times, only a few patients may contribute data. One has more confidence in the earlier data than in the later data. The fact that we would assign a higher quality score to the earlier results reflects this difference in confidence.

We assessed the quality of treatment studies using a two step process. First, we assigned a level of evidence to all results reported in a study based solely on that study's design. Accordingly, all data presented in randomized controlled trials were initially categorized as Level I evidence, all results presented in non-randomized controlled trials and other prospective comparative studies were initially categorized as Level II. We next assessed each outcome at each reported time point using a quality questionnaire and, when quality standards were not met, downgraded the level of evidence (for this outcome at this time point) by one level (see Appendix VI).

DIAGNOSTIC STUDIES

In studies investigating a diagnostic test, we used the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) instrument to identify potential bias and assess variability and the quality of reporting in studies reporting the effectiveness of diagnostic techniques.[14] We utilized a two step process to assess the quality of diagnostic studies. All studies enrolling a prospective cohort of patients are initially categorized as Level I studies. Any study that did not enroll the appropriate spectrum of patients (e.g. case-control studies) was initially categorized as a Level IV study. A study that we determined contained methodological flaws (i.e. QUADAS question answered 'no') that introduce bias were downgraded in a cumulative manner for each known bias (Appendix VI). For example, a study that is determined by the QUADAS instrument to have two biases is downgraded to Level III and a study that is determined to have four or more biases is downgraded to a Level V study. Those studies that do not sufficiently report their methods for a potential bias are downgraded to Level II since we are unable to determine if the bias did or did not bias the results of the study.

PROGNOSTIC STUDIES

In studies investigating the effect of a characteristic on the outcome of disease, we assessed quality using a two-step process. Any study that investigated a prospectively enrolled cohort of patients and utilized regression analysis was initially categorized as a Level I study. A study that used regression analysis in a retrospectively enrolled cohort of patients was categorized as a Level II study. We next assessed the outcome (dependent variable) for each prognostic factor (independent variable) using a quality questionnaire and, when quality standards were not met, we downgraded the level of evidence by one level (Appendix VI).

DEFINING THE STRENGTH OF THE RECOMMENDATIONS

Judging the quality of evidence is only a stepping stone towards arriving at the strength of a guideline recommendation. Unlike Levels of Evidence (which apply only to a given result at a given follow-up time in a given study) strength of recommendation takes into account the quality, quantity, and applicability of the available evidence. Strength also takes into account the trade-off between the benefits and harms of a treatment or diagnostic procedure, and the magnitude of a treatment's effect.

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 case series. Consequently, recommendations based on the former kind of evidence are given a high strength of recommendation and recommendations based on the latter kind of evidence are given a low strength.

To develop the strength of a recommendation, AAOS staff first assigned a preliminary strength for each recommendation that took only the quality and quantity of the available evidence into account (see Table 3). Work group members then modified the preliminary strength using the 'Form for Assigning Strength of Recommendation (Interventions)' shown in Appendix VII.

Table 3 Strength of recommendation descriptions

Statement Rating	Description of Evidence Strength	Implication for Practice
Strong	Evidence is based on two or more "High" strength studies with consistent findings for recommending for or against the intervention. A **Strong** recommendation means that the benefits of the recommended approach clearly exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a strong negative recommendation), and that the strength of the supporting evidence is high.	Practitioners should follow a **Strong** recommendation unless a clear and compelling rationale for an alternative approach is present.
Moderate	Evidence from two or more "Moderate" strength studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.	Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.
Limited	Evidence from two or more "Low" strength studies with consistent findings, or evidence from a single Moderate quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.	Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.
Inconclusive	Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.	Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.
Consensus[1]	The supporting evidence is lacking and requires the work group to make a recommendation based on expert opinion by considering the known potential harm and benefits associated with the treatment. A **Consensus** recommendation means that expert opinion supports the guideline recommendation even though there is no available empirical evidence that meets the inclusion criteria.	Practitioners should be flexible in deciding whether to follow a recommendation classified as **Consensus,** although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.

[1] The AAOS will issue a consensus-based recommendation only when the service in question has virtually no associated harm and is of low cost (e.g. a history and physical) or when not establishing a recommendation could have catastrophic consequences.

Each recommendation was written using language that accounts for the final strength of the recommendation. This language, and the corresponding strength, is shown in Table 4.

Table 4 AAOS guideline language

Guideline Language	Strength of Recommendation
We ***recommend***	Strong
We ***suggest***	Moderate
option	Limited
We are ***unable to recommend for or against***	Inconclusive
In the absence of reliable evidence, it is the ***opinion*** of this work group	Consensus*

*see Appendix VIII for development of opinion-based recommendations

CONSENSUS DEVELOPMENT

The recommendations and their strength were voted on using a structured voting technique known as the nominal group technique.[15] We present details of this technique in Appendix VIII. Voting on guideline recommendations was conducted using a secret ballot and work group members were blinded to the responses of other members. If disagreement between work group members was significant, there was further discussion to see whether the disagreement(s) could be resolved. Up to three rounds of voting were held to attempt to resolve disagreements. If disagreements were not resolved following three voting rounds, no recommendation was adopted. Lack of agreement is a reason that the strength for some recommendations is labeled "Inconclusive."

STATISTICAL METHODS

When possible the results of statistical analysis conducted by the AAOS Clinical Practice Guidelines Unit using STATA 10.0 (StataCorp LP, College Station, Texas) are reported. The program was used to determine the magnitude of the treatment effect. For data reported as means (and associated measures of dispersion) the standardized mean difference was calculated by the method of Hedges and Olkin.[16] For proportions, the odds ratio was calculated as a measure of treatment effect. When no events occur ("zero event") in a proportion, the variance of the arcsine difference was used to determine statistical significance ($p < 0.05$).[17]

When published studies report measures of dispersion other than the standard deviation the value was estimated to facilitate calculation of the treatment effect. In studies that report standard errors or confidence intervals the standard deviation was back-calculated. In studies that only report the median, range, and size of the trial, we estimated the means and variances according to a published method.[18] Studies that report results in graphical form were analyzed with TechDig 2.0 (Ronald B. Jones, Mundelein, Illinois) to estimate the mean and variance.

In some circumstances statistical testing was conducted by the authors and measures of dispersion were not reported. In the absence of measures of dispersion, the results of the statistical analyses conducted by the authors are included in the analysis and are identified as those of the study authors.

To determine if a study was sufficiently powered to detect the MCII, G*Power 3 (Franz Faul, Universitat Kiel, Germany) was used. For these calculations, 80% power, 95% confidence intervals, and the number of patients per group were used. This permits calculation of the minimal detectable effect size which was compared to the MCII effect size, reported above, to determine if the study was sufficiently powered to detect the MCII.

Likelihood ratios, sensitivity, specificity and 95% confidence intervals were used to determine the accuracy of diagnostic modalities based on two by two diagnostic contingency tables extracted from the included studies. When possible, prognostic factors were analyzed according to sensitivity and specificity as well.[19] Likelihood ratios are interpreted according to previously published values.[20] Likelihood ratios, sensitivity, specificity and 95% confidence intervals were calculated in STATA 10.0 using the "midas" command. For diagnostic meta-analysis the hierarchical summary receiver operating characteristic (HSROC) curve was used.[21, 22] This was implemented using the "metandi" command in STATA. Prediction regions are reported to assess heterogeneity.

PEER REVIEW

The draft of the guideline and evidence report was peer reviewed an expert, outside advisory panel that was nominated by the physician work group prior to the development of the guideline. Peer review was accomplished using a structured peer review form (see Appendix IX).

In addition, the physician members of the AAOS Guidelines and Technology Oversight Committee, the Evidence Based Practice Committee and the Chairpersons of the AAOS Occupational Health and Workers' Compensation Committee and the Medical Liability Committee were given the opportunity to provide peer review of the draft document.

We forwarded the draft guideline to a total of 28 peer reviewers and 13 returned reviews The disposition of all non-editorial peer review comments was documented and the guideline was modified in response to peer review. The peer reviews and the responses to them accompanied this guideline through the process of public commentary and the subsequent approval process. Peer reviewing organizations and peer reviewing individuals are listed in this document if they explicitly agree to allow us to publish this information (see Appendix X).

Peer review of an AAOS guideline does not imply endorsement. This is clearly stated on the structured review form (Appendix IX) sent to all peer reviewers and is also posted within the guideline (Appendix X). Endorsement cannot be solicited during the peer review process because the documents can still undergo substantial change as a result of both the peer review and public commentary processes. In addition, no guideline can be endorsed by specialty societies outside of the Academy until the AAOS Board of Directors has approved it. Organizations that provide peer review of a draft guideline will be solicited for endorsement once the document has completed the full review and approval processes.

PUBLIC COMMENTARY

After modifying the draft in response to peer review, the guideline was subjected to a thirty day period of "Public Commentary." Commentators consist of members of the AAOS Board of Directors (BOD), members of the Council on Research, Quality Assessment, and Technology (CORQAT), members of the Board of Councilors (BOC)*, and members of the Board of Specialty Societies (BOS)*. Based on these bodies, up to 185 commentators* had the opportunity to provide input into this guideline development process. Of these, XX returned public comments (see Appendix X).

*For this guideline, outside specialty societies could post the confidential draft of the guideline to their "member only" website. The responses garnered from this posting were compiled by the specialty society and submitted as one succinct public comment. In addition, members of the Board of Specialties (BOS) and Board of Councilors (BOC) were encouraged to provide input; including encouragement to seek input from colleagues not necessarily members of the BOS or BOC. As a result, the actual number of members who were given the opportunity to comment on this guideline exceeds the number of public commentators for previous guidelines.

THE AAOS GUIDELINE APPROVAL PROCESS

Following public commentary, the draft was again modified by the AAOS Clinical Practice Guidelines Unit and work group members. This final guideline draft was approved by the AAOS Guidelines Oversight Committee, the AAOS Evidence Based Practice Committee, the AAOS Council on Research, Quality Assessment, and Technology, and the AAOS Board of Directors. Descriptions of these bodies are provided in Appendix II.

REVISION PLANS

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

GUIDELINE DISSEMINATION PLANS

The primary purpose of the present document is to provide interested readers with full documentation about not only our recommendations, but also about how we arrived at those recommendations. This document is also posted on the AAOS website at http://www.aaos.org/research/guidelines/guide.asp.

Shorter versions of the guideline are available in other venues. Publication of most guidelines is announced by an Academy press release, articles authored by the work group and published in the Journal of the American Academy of Orthopaedic Surgeons, and articles published in AAOS *Now*. Most guidelines are also distributed at the AAOS

Annual Meeting in various venues such as on Academy Row and at Committee Scientific Exhibits.

Selected guidelines are disseminated by webinar, an Online Module for the Orthopeadic Knowledge Online website, Radio Media Tours, Media Briefings, and by distributing them at relevant Continuing Medical Education (CME) courses and at the AAOS Resource Center.

Other dissemination efforts outside of the AAOS will include submitting the guideline to the National Guideline Clearinghouse and distributing the guideline at other medical specialty societies' meetings.

III. RECOMMENDATIONS AND SUPPORTING DATA

RECOMMENDATION 1

We are unable to recommend for or against performing nerve decompression when nerve dysfunction persists after reduction.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

There were no qualified studies identified that addressed this recommendation.

Supporting Evidence:

Evidence Tables 1 - 3 in supplemental evidence table document.

We identified only one study that enrolled patients with persistent nerve dysfunction after reduction (and before surgery) of a distal radius fracture and met our inclusion critera.[23] This study used subjective (symptoms) and objective (clinical test) measures to determine the persistence of nerve dysfunction after reduction. Patients with symptoms and a positive clinical test underwent nerve exploration (i.e. carpal tunnel release) and all other patients did not undergo nerve exploration. Patients receiving carpal tunnel release may have had spontaneous resolution of symptoms or may have benefited from carpal tunnel release. The spontaneous resolution of symptoms in patients not receiving carpal tunnel release may support this.

RECOMMENDATION 2

We are unable to recommend for or against casting as definitive treatment for unstable fractures that are initially adequately reduced.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

There were no qualified studies identified that addressed this recommendation.

Supporting Evidence:

Evidence Table 4 in supplemental evidence table document.

There were no studies investigating the role of conservative treatment in adequately reduced and maintained unstable fractures that met our inclusion criteria.

RECOMMENDATION 3

We suggest operative fixation for fractures with post-reduction radial shortening >3mm, dorsal tilt >10 degrees, or intra-articular displacement or step-off >2mm as opposed to cast fixation.

Strength of Recommendation: Moderate

Description: Evidence from two or more “Moderate” strength studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention. A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.

Implications: Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.

Rationale:

Five randomized clinical trials met our inclusion criteria and compared fixation to cast immobilization.[24-28] All had at least one methodological flaw and were downgraded to Level II. All mixed articular fractures and extra-articular fracture in a manner which did not allow for separate analysis. There were no age criteria and the average patient age in these trials was similar to those that address treatment in older-aged patients (see Recommendation 5). There were differences in pain at 24 and 52 weeks, but not 8 and 12 weeks in one study, differences in motion at 52 weeks in one study, and differences in complications, overall, in 4 studies. The differences were all in favor of operative treatment. Complications included carpal tunnel syndrome, thumb pain, ulnar nerve symptoms, and malunion. The moderate strength of the data is therefore based primarily on differences in complications, which can be somewhat variably defined.

Fracture instability is difficult to define, but was consistently defined within these studies as loss of radiographic alignment after initial closed reduction and splinting in each of these trials.

Table 5 Summary table for Recommendation 3

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored treatment
Abbaszadegan	46	II	Pain	8 weeks	○
Abbaszadegan	46	II		12 weeks	○
Abbaszadegan	46	II		24 weeks	Ex-fix*
Abbaszadegan	46	II		52 weeks	Ex-fix*
Young	85	II		7 years	○
Abbaszadegan	46	II	Function	8 weeks	○
Abbaszadegan	46	II		12 weeks	○
Abbaszadegan	46	II		24 weeks	○
Abbaszadegan	46	II		52 weeks	Ex-fix*
McQueen	120	II	Complications	n/a	Ex-fix
Howard	50	II			
Young	85	II			
Pring	76	II			

* reported by study author(s), Ex-fix: External fixation, ○: no significant difference

Supporting Evidence:

Evidence Tables 5 - 7 in supplemental evidence table document.

The amount of pain in patients treated with external fixation was not significantly different from the pain in patients treated with casting at 8 or 12 weeks post-operatively but was significantly lower 24 weeks post-operatively and remained significant up to 1 year (Table 6). However, the number of patients pain free after 7 years was not significantly different between external fixation and casting (Table 7). Additionally, function was significantly better after 1 year in patients treated by external fixation but not significantly different at 8, 12, or 24 weeks (Table 6).

There are several complications reported in the included studies (Figure 1 and Table 8). Seven of the eleven reported complications did not occur significantly more or less in patients treated with cast or external fixation. Statistically significant differences between patients treated with operative fixation and casting favored patients treated with external fixation (fewer occurrences of malunion, CTS, ulnar nerve symptoms, and thumb pain). However, there are complications unique to external fixation that patients treated with casting are not exposed to (Table 9).

Table 6 Pain and function in patients treated with cast or external fixation

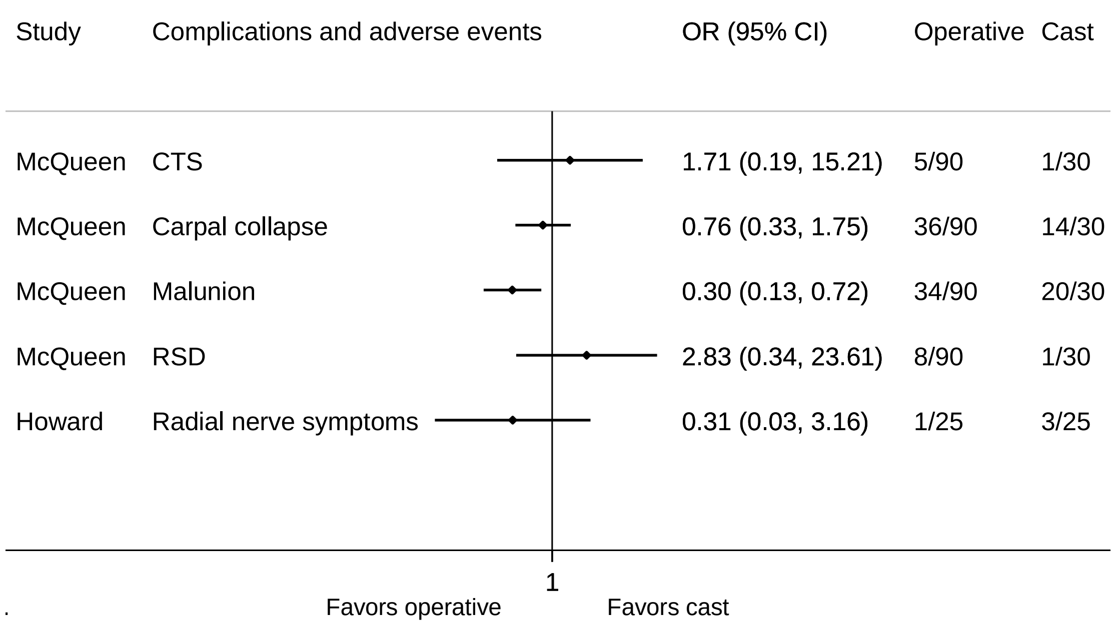
Study	Outcome	Duration	External fixation (median)	Cast (median)
Abbaszadegan	Pain - VAS	8 weeks	2	3
Abbaszadegan	Pain - VAS	12 weeks	1	2
Abbaszadegan	Pain - VAS	24 weeks	0.5	2
Abbaszadegan	Pain - VAS	52 weeks	0	1
Abbaszadegan	Function - VAS	8 weeks	7	5
Abbaszadegan	Function - VAS	12 weeks	7	7
Abbaszadegan	Function - VAS	24 weeks	9	8
Abbaszadegan	Function - VAS	52 weeks	10	9

Shaded cells indicate statistically significant differences identified by the study authors (t-test, $p < 0.05$)

Table 7 Pain free patients after treatment with cast or external fixation

Study	Outcome	Duration	Cast n/N	External fixation n/N	OR (95%CI)
Young	Pain free	7 years	30/36 patients	39/49 patients	1.28 (0.42, 3.92)

Figure 1 Complications in patients treated with external fixation or cast



Malunion was determined at 6 - 52 weeks post-operatively

Table 8 Zero event complications in patients treated with operative intervention or cast

Study	Intervention	Complications	Operative n/N	Cast n/N	p-value*
Young	Ex-fix	CTS	0/36	0/49	1.00
Howard	Ex-fix	CTS	0/25	4/25	0.004
McQueen	Ex-fix	Dorsal medial nuerapraxia	2/90	0/30	0.16
Young	Ex-fix	Persistent weakness	1/36	0/49	0.13
Howard	Ex-fix	RSD	0/25	0/25	1.00
Young	Ex-fix	RSD	0/36	1/49	0.19
McQueen	Ex-fix	Tendon rupture	1/90	0/30	0.32
Howard	Ex-fix	Tendon rupture	0/25	1/25	0.15
Young	Ex-fix	Tendon rupture	0/36	2/49	0.06
Pring	Bipolar-fix†	Thumb pain	9/36	0/40	0.000
Howard	Ex-fix	Ulnar nerve symptoms	0/25	2/25	0.04
McQueen	Ex-fix	Wound/superficial infection	2/90	0/30	0.15

*test of arcsine difference, shaded cells indicates favored group if statistically significant
† Pins incorporated with cast (two radial, one metacarpal)[28]

Table 9 Complications specific to operative intervention compared to cast

Study	Intervention	Complications	Operative n/N
Howard	External fixation	Infection of pin tract	2/25
Pring	Bipolar fixation†	Loosening of pin or low grade sepsis	7/36
Pring	Bipolar fixation†	Migrated pin	1/36
Pring	Bipolar fixation†	Fracture through pin hole	1/36

† Pins incorporated with cast (two radial, one metacarpal)[28]

RECOMMENDATION 4

We are unable to recommend for or against any one specific operative method for fixation of distal radius fractures.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

Fourteen clinical trials met the inclusion criteria: 8 combined intra- and extra- articular fractures,[29-36] 5 studied only intra-articular fractures,[37-41] and one studied only extra-articular fractures.[42] No studies evaluated shearing/articular rim fractures, or radiocarpal fracture-dislocations. Inclusion was based on inadequate radiographic alignment after initial adequate closed reduction and splint immobilization. Thus, the included studies did not allow for stratification by fracture type. Only two comparisons were made by more than one study making meta-analysis impossible (Figure 2). All had at least one methodological flaw and were downgraded to Level II.

The included studies in this recommendation do not address many important aspects of the operative treatment of distal radius fractures, including different operative treatments for different fracture types. Therefore, it is not possible to come to an evidence based conclusion for the optimal operative treatment of distal radius fractures.

Only three of 14 studies had statistically significant findings. In one study, there was only a statistically significant difference in complications. In another study, there was a possibly clinically important difference in DASH at 1 year but not at 3 or 6 months. In the third study, there was statistically significant better function at 2 years for percutaneous fixation over ORIF. All other outcomes evaluated by the included studies were not statistically significant (Table 10).

Supporting Evidence:

Evidence Tables 8 - 10 in supplemental evidence table document.

Results of each comparison indicated in Figure 2 are presented independently in the sections below.

Figure 2 Operative techniques for DRF compared in randomized controlled trials included in this systematic review

	PERCUTANEOUS FIXATION	EXTERNAL FIXATION	with pins	without pins	bridging	non-bridging	pins and plaster	INTERNAL FIXATION	volar plate	dorsal plate	radial plate	intrameduallry	fragment specific	bio-resorbable plate	bridge plate
PERCUTANEOUS FIXATION			**1**		**1**			**1**							
EXTERNAL FIXATION							**2**								
with pins				**1**				**1**							
without pins															
bridging						**3**			**1**			**1**			
non-bridging															
pins and plaster															
INTERNAL FIXATION										**1**				**1**	
volar plate															
dorsal plate															
radial plate															
intrameduallry															
fragment specific															
bio-resorbable plate															
bridge plate															

Table 10 Summary Table for Recommendation 4

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored treatment

Closed reduction and percutaneous fixation vs. ORIF

Kreder	118	II	Function	2 years	**Closed reduction & percutaneous fixation**
Kreder	118	II	Pain	2 years	○

Non-bridging vs. bridging external fixation

Krukhaug	71	II	Function	1 year	true negative
Krishnan	60	II	Pain	6 weeks	○
Krishnan	60	II		26 weeks	○
McQueen	56	II		1 year	○
Krukhaug	71	II	Complications	n/a	○
Krishnan	60	II			
McQueen	56	II			

Augmented bridging external fixation vs. percutaneous pinning

Harley	41	II	Function	6 months	true negative
Harley	41	II	Physical health	6 months	○
Harley	33	II		12 months	○
Harley	41	II	Mental health	6 months	○
Harley	33	II		12 months	○

Augmented bridging external fixation vs. bridging external fixation

Werber	50	II	Complications	n/a	○

Augmented bridging external fixation vs. plate(s)

Leung	144	II	Activity	Final follow-up	○
Leung	144	II	Complications	n/a	○

○: no significant difference

continued next page

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored treatment

Augmented bridging external fixation vs. volar locking plate

Egol	77	II	Function	3 months	true negative
Egol	77	II		6 months	true negative
Egol	77	II		1 year	possibly clinically important favoring **VLP**
Egol	77	II	Pain	3 months	○
Egol	77	II		6 months	○
Egol	77	II		1 year	○
Egol	77	II	Complications	n/a	○

Bridging external fixation vs. percutaneous pinning

Ludvigsen	60	II	Complications	n/a	○

Bridging external fixation vs. medullary pinning

Pritchett	100	II	Complications	n/a	**Medullary pinning**

Bridging external fixation vs. pins and plaster

Raskin	60	II	Activity	Final follow-up	○
Raskin	60	II	Complications	n/a	○
Hutchinson	85	II			

Dorsal locking plate vs. dual plating

Hahnloser	46	II	Pain	6 months	○
Hahnloser	46	II	Activity	6 months	○

Dorsal locking plate vs. dual plating

not powered to detect MCII of DASH

○: no significant difference

CLOSED REDUCTION AND PERCUTANEOUS FIXATION VS. OPEN REDUCTION AND INTERNAL FIXATION

Supporting Evidence:

We identified one randomized controlled trial comparing closed reduction and percutaneous fixation to open reduction and internal fixation (ORIF) that met our inclusion criteria.[31] Patients treated with closed reduction and percutaneous fixation had significantly better function and no difference in pain (Table 11). Tendon rupture occurred significantly less in patients treated with closed reduction and percutaneous fixation, and no other complication reported by the authors was statistically significant (Figure 3 and Table 12)

Table 11 Function and pain in patients treated with 'closed reduction and percutaneous fixation' or ORIF

Study	N	Outcome	Duration	Difference between groups (95% CI)	Favors
Kreder	118	Musculoskeletal Functional Assessment (MFA) of the upper limb	2 years	18.6 (4.1, 33.0)*	Closed Reduction and Percutaneous Fixation*
Kreder	118	SF-36 (bodily pain)	2 years	0.452 (-0.1, 1.5)*	Neither*

* result of repeated measures ANOVA reported by study author(s)

Figure 3 Complications in patients treated with ‘closed reduction and percutaneous fixation’ or ORIF

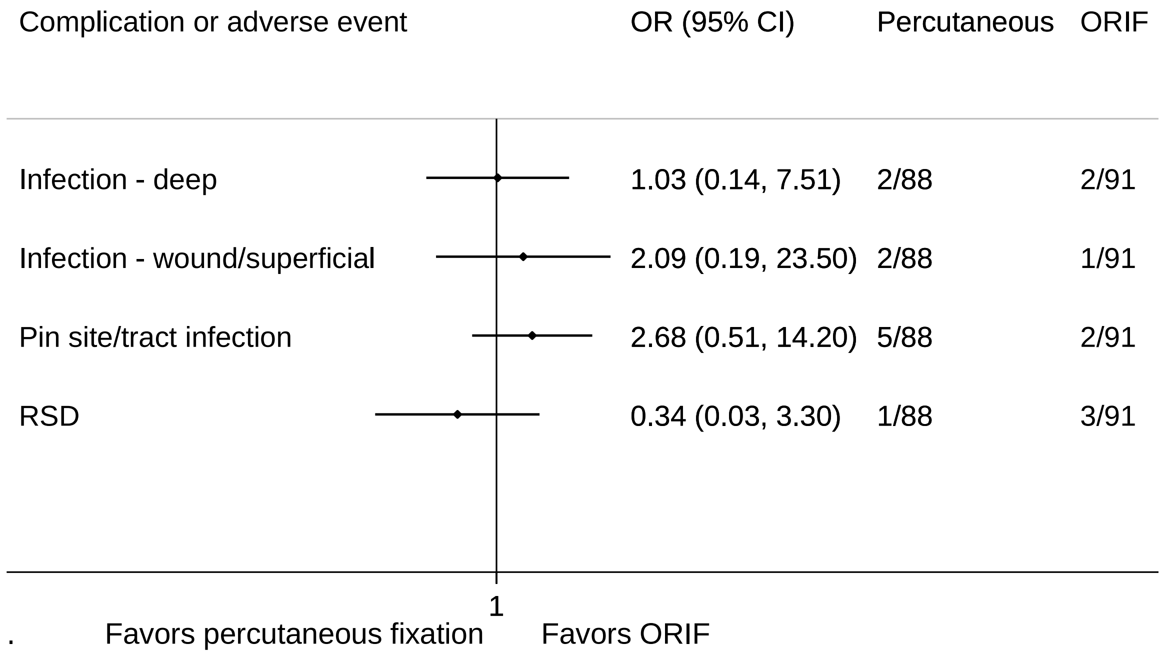


Table 12 Zero event complications in patients treated with ‘closed reduction and percutaneous fixation or ORIF

Study	Complications	Percutaneous n/N	ORIF n/N	p-value*
Kreder	Tendon rupture	0/88	2/91	0.05

*test of arcsine difference, shaded cells indicates favored group if statistically significant

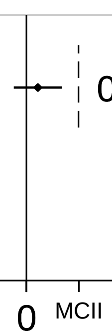
NON-BRIDGING VS. BRIDGING EXTERNAL FIXATION

Supporting Evidence:

We identified three randomized controlled trials comparing non-bridging external fixation to bridging external fixation that met our inclusion criteria. [33, 36, 42] Function and pain determined by the DASH score showed no significant difference between groups (Figure 4). This result is a true negative, suggesting that patients treated with non-bridging external fixation or bridging external fixation had similar outcomes 1 year after surgery. Pain measured by visual analog scale (VAS) up to 1 year was not significantly different in patients treated with non-bridging or bridging external fixation (Table 13 and Table 14) Pain at different anatomic locations on or around the distal radius was not significantly different in patients treated with non-bridging or bridging external fixation (Figure 5). Statistically significant complications occurred in favor of non-bridging external fixation and in favor of bridging external fixation (Figure 6 and Table 15). Tendon rupture occurred significantly more in patients treated with non-bridging external fixation and malunion occurred significantly more in patients treated with bridging external fixation (Table 15).

Figure 4 DASH score in patients treated with bridging external fixation or non-bridging external fixation

DASH	SMD (95% CI)	N, mean (SD); Bridging	N, mean (SD); Non-bridging
1 year	0.21 (-0.24, 0.67)	38, 13 (21.3)	37, 9 (15)



. Favors bridging Favors non-bridging

Table 13 Median VAS pain score in patients treated with bridging external fixation or non-bridging external fixation

Study	Outcome	Duration	Bridging	Non-bridging
Krishnan	Pain - VAS	6 weeks	0.9	1.4
Krishnan	Pain - VAS	26 weeks	0	0

no significant difference reported by study authors, no measures of dispersion reported by author(s)

Table 14 Mean VAS pain score in patients treated with bridging external fixation or non-bridging external fixation

Study	Outcome	Duration	Bridging	Non-bridging
McQueen	Pain - VAS	1 year	1.3	1.2

no significant difference reported by study authors, no measures of dispersion reported by author(s)

Figure 5 Pain in patients treated with bridging external fixation or non-bridging external fixation

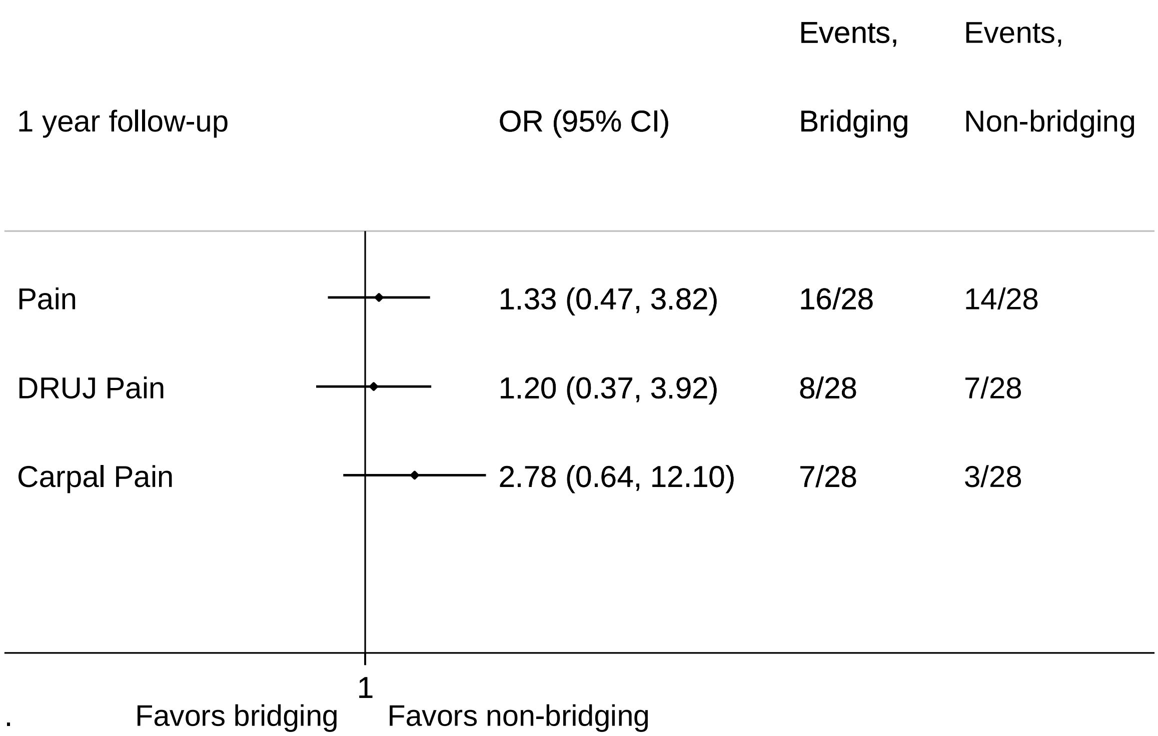


Figure 6 Complications in patients treated with bridging external fixation or non-bridging external fixation

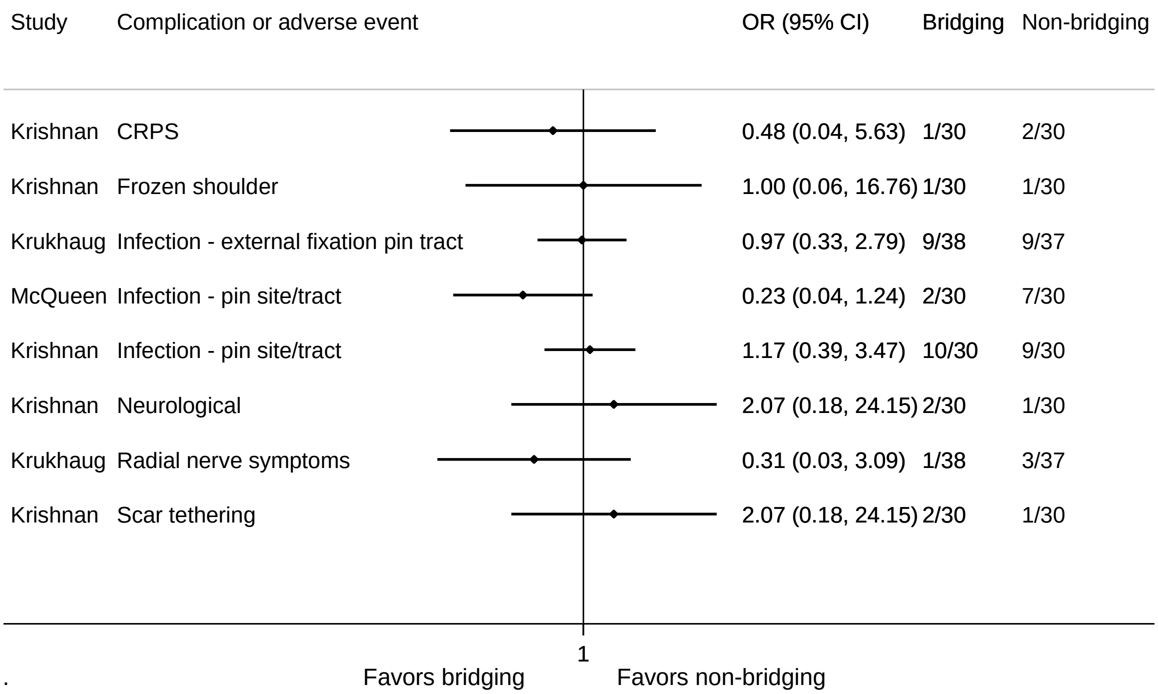


Table 15 Zero event complications in patients treated with bridging external fixation or non-bridging external fixation

Study	Complications	Bridging n/N	Non-bridging n/N	p-value*
Krukhaug	CRPS	0/38	0/37	1.00
Krukhaug	Infection - deep	0/38	0/37	1.00
McQueen	CRPS	2/30	0/30	0.04
McQueen	Malunion	14/30	0/30	0.000
McQueen	Tendon rupture	0/30	2/30	0.04
Krishnan	Tendon rupture	0/30	3/30	0.01

*test of arcsine difference, shaded cells indicates favored group if statistically significant

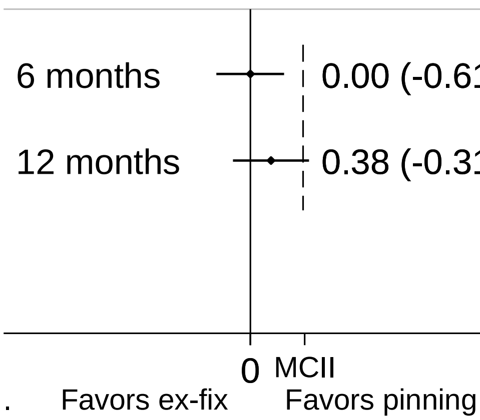
AUGMENTED BRIDGING EXTERNAL FIXATION VS. PERCUTANEOUS PINNING

Supporting Evidence:

We identified one randomized controlled trial comparing augmented bridging external fixation to percutaneous pinning that met our inclusion criteria.[32] Function and pain determined by the DASH score showed no significant difference between groups (Figure 7). At six months, this result is a true negative, suggesting that patients treated with augmented external fixation or percutaneous pinning had similar outcomes. However, the results at twelve months are inconclusive. Overall mental and overall physical health was not significantly different between patients treated with augmented external fixation or percutaneous pinning (Figure 8 and Figure 9).

Figure 7 DASH score in patients treated with augmented external fixation or percutaneous pinning

DASH	SMD (95% CI)	N, mean (SD); Augmented External Fixation	N, mean (SD); Percutaneous Pinning
6 months	0.00 (-0.61, 0.61)	21, 22 (19)	20, 22 (22)
12 months	0.38 (-0.31, 1.07)	17, 23 (23)	16, 15 (18)



At 12 months the study was not powered to detect the MCII of the DASH instrument

Figure 8 SF-36 physical component score in patients treated with augmented external fixation or percutaneous pinning

SF-36 (physical)	SMD (95% CI)	N, mean (SD); Percutaneous Pinning	N, mean (SD); Augmented External FIxation
6 months	-0.21 (-0.83, 0.40)	20, 46 (11)	21, 48 (7)
12 months	0.27 (-0.42, 0.95)	16, 48 (11)	17, 45 (11)

0

. Favors ex-fix Favors pinning

Figure 9 SF-36 mental component score in patients treated with augmented external fixation or percutaneous pinning

SF-36 (mental)	SMD (95% CI)	N, mean (SD); Percutaneous Pinning	N, mean (SD); Augmented External Fixation
6 months	0.29 (-0.33, 0.90)	20, 54 (8)	21, 51 (12)
12 months	0.19 (-0.49, 0.87)	16, 54 (8)	17, 52 (12)

0

. Favors ex-fix Favors pinning

AUGMENTED BRIDGING EXTERNAL FIXATION VS. BRIDGING EXTERNAL FIXATION

Supporting Evidence:

We identified one randomized controlled trial comparing augmented bridging external fixation (by addition of a fifth external fixator pin) to bridging external fixation that met our inclusion criteria.[34] The study did not report validated patient oriented outcomes. There were no statistically significant differences in the occurrence of complications between patients treated with augmented bridging external fixation or bridging external fixation (Figure 10 and Table 16).

Figure 10 Complications in patients treated with external fixation or augmented external fixation

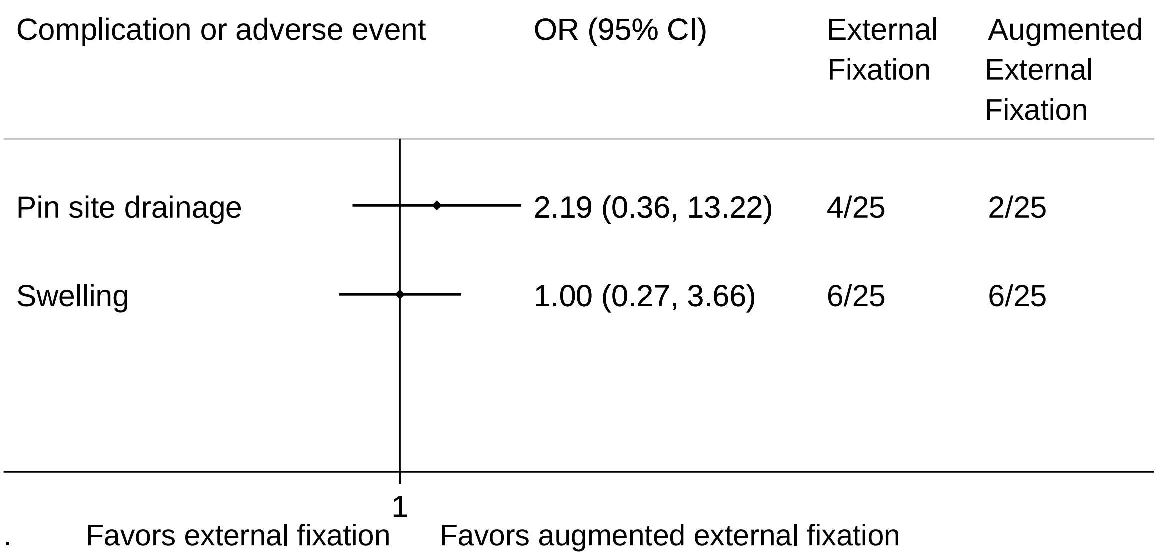


Table 16 Zero event complications in patients treated with external fixation or augmented external fixation

Study	Complications	External fixation n/N	Augmented external fixation n/N	p-value*
Werber	Tendon rupture	0/25	0/25	1.00
Werber	Nerve compression syndrome	0/25	0/25	1.00
Werber	RSD	0/25	0/25	1.00

*test of arcsine difference, shaded cells indicates favored group if statistically significant

AUGMENTED BRIDGING EXTERNAL FIXATION VS. PLATE(S)

Supporting Evidence:

We identified one randomized controlled trial comparing augmented bridging external fixation to plate fixation that met our inclusion criteria.[37] Activity at final follow-up was similar in patients treated with augmented external fixation or plate fixation (Figure 11). Statistically significant complications occurred in favor of augmented bridging external fixation and in favor of plate(s) (Figure 12 and Table 17) Median nerve symptoms occurred significantly more often in patients treated with plate fixation, and radial nerve symptoms occurred significantly more often in patients treated with external fixation. Additionally, infection of pin tracts was reported in patients treated with external fixation. Patients treated by plate fixation are not subject to this complication (Table 18).

Figure 11 Activity in patients treated with augmented external fixation or plate(s)

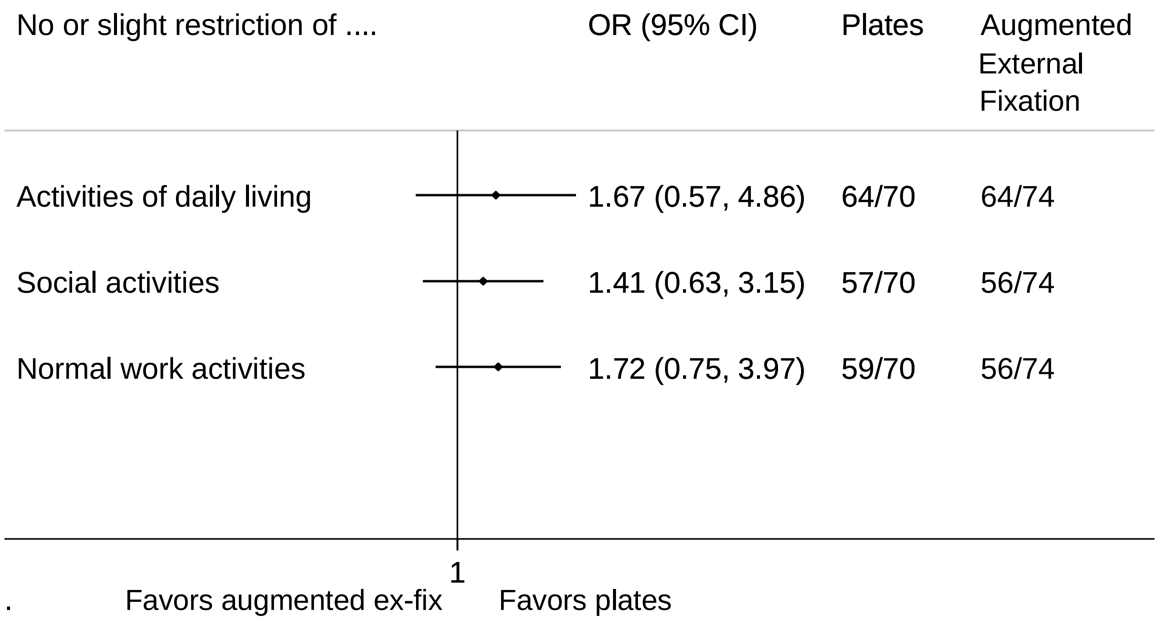


Figure 12 Complications in patients treated with augmented external fixation or plate(s)

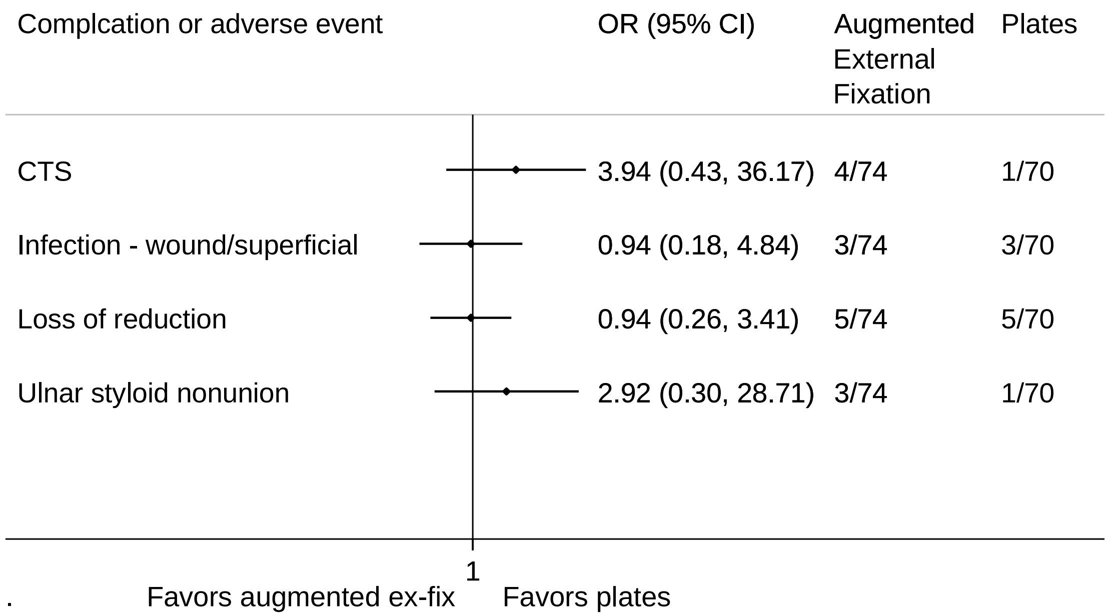


Table 17 Zero event complications in patients treated with augmented external fixation or plate(s)

Study	Complications	Augmented external fixation n/N	Plate(s) n/N	p-value*
Leung	CRPS	1/74	0/70	0.16
Leung	Frozen shoulder	1/74	0/70	0.16
Leung	Median nerve symptoms	0/74	2/70	0.04
Leung	Radial nerve symptoms	3/74	0/70	0.02
Leung	Ulnar nerve symptoms	0/74	1/70	0.15
Leung	Tendinitis	0/74	1/70	0.15

*test of arcsine difference, shaded cells indicates favored group if statistically significant

Table 18 Complications specific to augmented external fixation

Study	Complications	Augmented external fixation n/N
Leung	External fixation pin tract infection	5/74

AUGMENTED BRIDGING EXTERNAL FIXATION VS. VOLAR LOCKING PLATE

Supporting Evidence:

We identified one randomized controlled trial comparing augmented bridging external fixation to volar locking plate fixation that met our inclusion criteria.[29] At 1 year, the DASH results were possibly clinically important, and patients treated with volar locking plates had better function than patients treated with augmented external fixation (Figure 13). However, pain at 1 year was not significantly different between these groups of patients (Figure 14). There were no statistically significant differences in complications between patients treated with augmented bridging external fixation or volar locking plate fixation (Figure 15 and Table 19) However, both interventions have unique complications (Table 20).

Figure 13 DASH score in patients treated with augmented external fixation or volar locking plate

DASH	SMD (95% CI)	N, mean (SD); Augmented External Fixation	N, mean (SD); Volar Locking Plate
3 months	0.28 (-0.17, 0.73)	38, 25.4 (21.1)	39, 19.5 (20.1)
6 months	0.33 (-0.12, 0.78)	38, 32.6 (23.8)	39, 25 (21.7)
1 year	0.82 (0.35, 1.28)	38, 33.7 (17.2)	39, 13 (30.9)

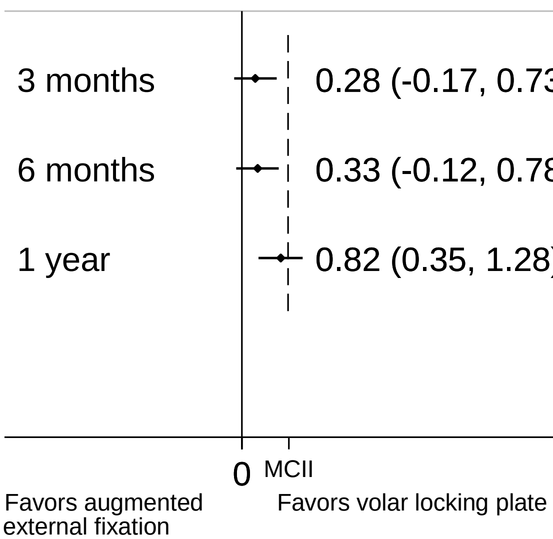


Figure 14 Pain in patients treated with augmented external fixation or volar locking plate

Pain - VAS	SMD (95% CI)	N, mean (SD); Augmented External Fixation	N, mean (SD); Volar Locking Plate
3 months	-0.21 (-0.66, 0.24)	38, 1.8 (2.2)	39, 2.3 (2.5)
6 months	-0.13 (-0.57, 0.32)	38, 2.3 (2.3)	39, 2.6 (2.4)
1 year	-0.14 (-0.59, 0.31)	38, 2.1 (2.7)	39, 2.5 (2.9)

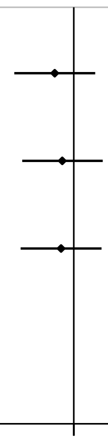


Figure 15 Complications in patients treated with augmented external fixation or volar locking plate

Complcation or adverse event	OR (95% CI)	Augmented External Fixation	Volar Locking Plate
Post-op nerve deficit	1.54 (0.24, 9.68)	3/44	2/44
Tendinitis	0.25 (0.03, 2.33)	1/44	4/47
Tendon rupture	0.49 (0.04, 5.59)	1/44	2/44

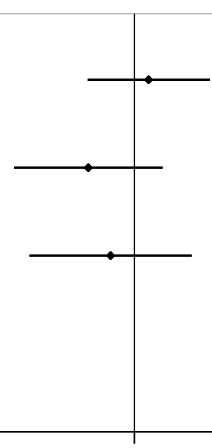


Table 19 Zero event complications in patients treated with augmented external fixation or volar locking plate

Study	Complications	Augmented external fixation n/N	Volar locking plate n/N	p-value*
Egol	Infection - wound/superficial	0/44	1/44	0.16
Egol	Nonunion	0/44	1/44	0.16

*test of arcsine difference, shaded cells indicates favored group if statistically significant

Table 20 Complications specific to augmented external fixation or volar locking plate

Study	Complications	Augmented external fixation n/N	Volar locking plate n/N
Egol	External fixation pin tract infection	2/44	n/a
Egol	Painful retained hardware	n/a	1/44
Egol	Plate removal	n/a	2/44

BRIDGING EXTERNAL FIXATION VS. PERCUTANEOUS PINNING

Supporting Evidence:

We identified one randomized controlled trial comparing bridging external fixation to percutaneous pinning that met our inclusion criteria.[38] The study did not report validated patient oriented outcomes. There were no statistically significant differences in the occurrence of complications between patients treated with bridging external fixation or percutaneous pinning (Figure 16 and Table 21).

Figure 16 Complications in patients treated with external fixation or percutaneous pinning

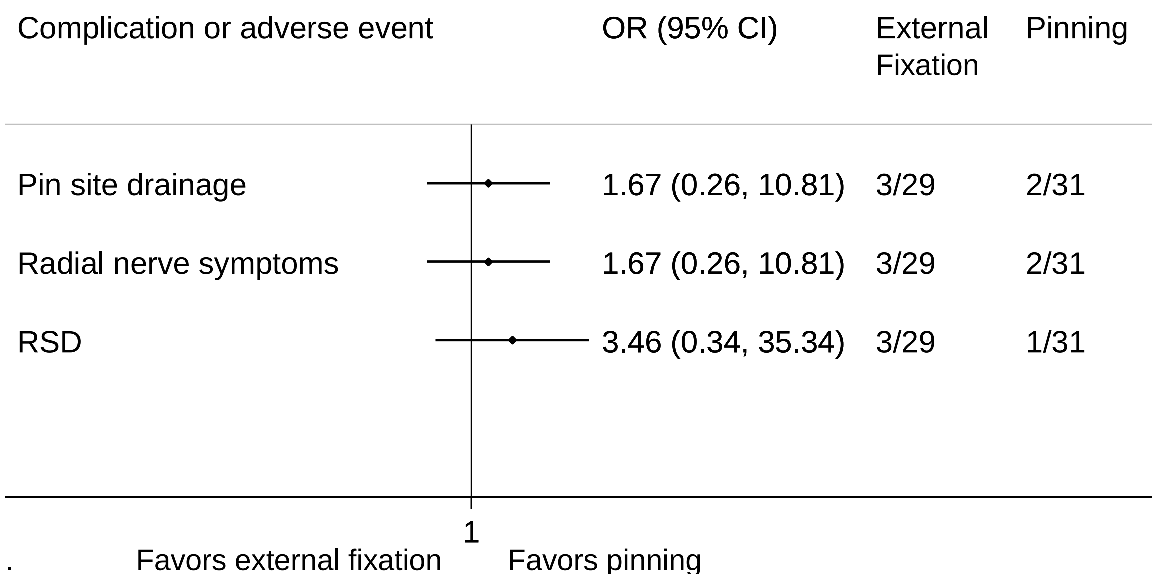


Table 21 Zero event complications in patients treated with external fixation or percutaneous pinning

Study	Complications	External fixation n/N	Pinning n/N	p-value*
Ludvigsen	Loosening of pin	0/29	0/31	1.00
Ludvigsen	Low grade sepsis	0/29	0/31	1.00
Ludvigsen	Median nerve symptoms	0/29	0/31	1.00
Ludvigsen	Ulnar nerve symptoms	0/29	0/31	1.00

*test of arcsine difference, shaded cells indicates favored group if statistically significant

BRIDGING EXTERNAL FIXATION VS. MEDULLARY PINNING

Supporting Evidence:

We identified one randomized controlled trial comparing bridging external fixation to medullary pinning that met our inclusion criteria.[40] The study did not report validated patient oriented outcomes but reports complications. There were significantly more occurrences of infection, median nerve symptoms, and shoulder pain in patients treated with external fixation than those treated with medullary pinning (Figure 17 and Table 22).

Figure 17 Complications in patients treated with external fixation or medullary pinning

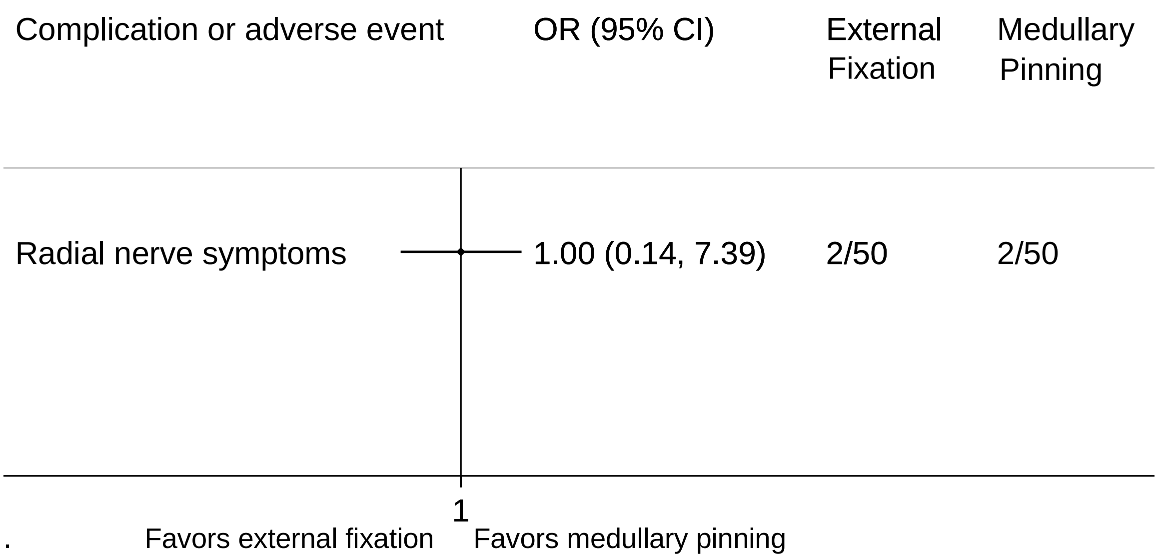


Table 22 Zero event complications in patients treated with external fixation or medullary pinning

Study	Complications	External fixation n/N	Medullary pinning n/N	p-value*
Pritchett	Infection - pin site/tract	8/50	0/50	0.000
Pritchett	Infection - osteomyelitis	1/50	0/50	0.16
Pritchett	Median nerve symptoms	2/50	0/50	0.04
Pritchett	Ulnar nerve symptoms	1/50	0/50	0.16
Pritchett	Shoulder pain	6/50	0/50	0.00

*test of arcsine difference, shaded cells indicates favored group if statistically significant

BRIDGING EXTERNAL FIXATION VS. PINS AND PLASTER

Supporting Evidence:

We identified two randomized controlled trials comparing bridging external fixation to pins and plaster fixation that met our inclusion criteria.[39, 41] Return to activities of daily living was achieved by all patients treated with external fixation or pins and plaster (Table 23). Statistically significant complications occurred in favor of bridging external fixation and in favor of pins and plaster fixation (Figure 18 and Table 24). Patients treated with external fixation developed pin tract infections and radial nerve symptoms significantly more often than patients treated with pins and plaster fixation. Patients with pins and plaster fixation experienced significantly more loose pins than patients treated with external fixation.

Table 23 Activity in patients treated with external fixation or pins and plaster

Study	Outcome	External fixation n/N	Pins and plaster n/N
Raskin	Return to activities of daily living	30/30 patients	30/30 patients

Figure 18 Complications in patients treated with external fixation or pins and plaster

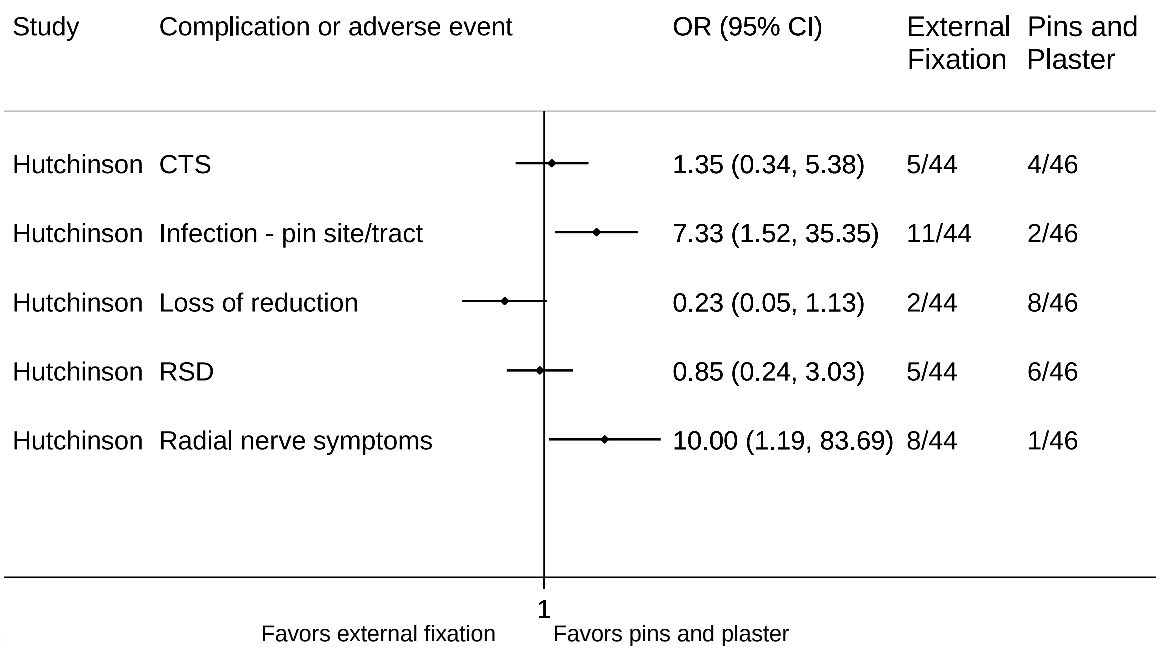


Table 24 Zero event complications in patients treated with external fixation or pins and plaster

Study	Complications	External fixation n/N	Pins and plaster n/N	p-value*
Raskin	Finger stiffness	0/30	0/30	1.00
Raskin	Infection - osteomyelitis	0/30	0/30	1.00
Raskin	Infection - pin site/tract	0/30	1/30	0.16
Hutchinson	Loose pin	0/44	3/46	0.01
Raskin	Loss of reduction	1/30	0/30	0.16
Raskin	Migrated pin	0/30	1/30	0.16
Raskin	Neuropathy	0/30	0/30	1.00
Hutchinson	Pin fracture	0/44	1/46	0.16
Raskin	Pin fracture	0/30	0/30	1.00
Raskin	Pin tract inflammation	2/30	0/30	0.04
Raskin	RSD	0/30	0/30	1.00
Raskin	Secondary operations	0/30	0/30	1.00

*test of arcsine difference, shaded cells indicates favored group if statistically significant

DORSAL LOCKING PLATE VS. DUAL PLATES

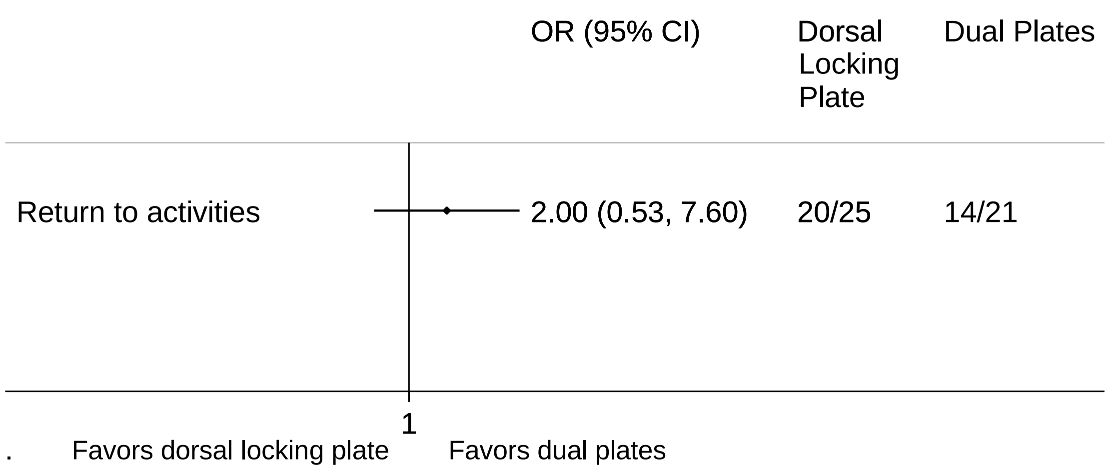
Supporting Evidence:

We identified one randomized controlled trial comparing dorsal locking plate fixation to dual plate fixation that met our inclusion criteria.[35] Pain at 6 months after surgery was similar between the two groups and there was no statistically significant difference in return to activities for patients treated with a dorsal locking plate or dual plates (Table 25 and Figure 19).

Table 25 Pain in patients treated with dorsal locking plate or dual plates

Study	Outcome	Duration	Dorsal locking plate n/N	Dual Plates n/N
Hahnloser	No Pain	6 months	7/21 patients	11/25 patients
Hahnloser	Mild Pain	6 months	12/21 patients	11/25 patients
Hahnloser	Moderate Pain	6 months	1/21 patients	3/25 patients
Hahnloser	Severe Pain	6 months	1/21 patients	0/25 patients

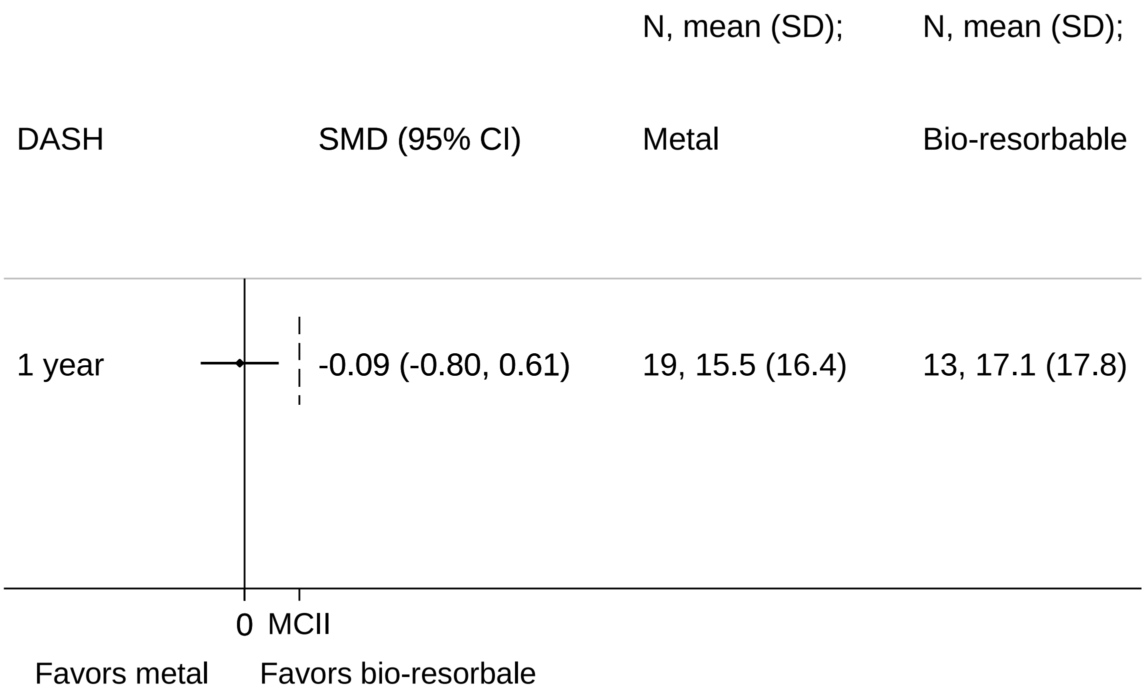
Figure 19 Return to activities in patients treated with dorsal locking plate or dual plates



BIO-RESORBABLE PLATES VS. METAL PLATES

We identified one randomized controlled trial comparing bio-resorbable plate fixation to metal plate fixation that met our inclusion criteria.[30] The result of the DASH score reported in this study is difficult to interpret because of the lack of statistical power.

Figure 20 DASH score in patients treated with bio-resorbable plate or metal plate



The study was not powered to detect the MCII of the DASH instrument

RECOMMENDATION 5

We are unable to recommend for or against operative treatment for patients over age 55 with distal radius fractures.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

We were interested in determining the role of operative treatment compared to non-operative treatment of patients defined by the published literature as "elderly" and that distinguished patients based on infirmity, functional demands, bone quality, or energy of injury. Three clinical trials met the inclusion criteria.[43-45] Two trials compared external fixation to cast immobilization and one trial compared percutaneous pinning to cast immobilization. All had at least one methodological flaw and were downgraded to Level II. One addressed extra-articular fractures, one articular fractures, and one both. Age criteria included age over 55 in 2 studies and over age 60 in one study. We selected the age of 55 because these included studies enrolled patients no younger than 55 years. We were unable to identify studies that distinguished patients based on infirmity, functional demands, bone quality, or energy of injury. The average patient age in these trials was comparable to those considered in Recommendation 3. Inclusion was based on redisplacement in one study, initial radiographic alignment in one study, and instability not otherwise defined in one study. There were no differences in pain, function, complications or SF-36 at any time point.

Table 26 Summary table for Recommendation 5

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored treatment
Azzopardi	57	II	Pain	1 year	○*
Azzopardi	57	II	Mental health	1 year	○*
Azzopardi	57	II	Physical health	1 year	○*
Azzopardi	57	II	Complications	n/a	○*
Hegeman	32	II	Pain	6 weeks	○**
Hegeman	32	II		3 months	○**

Roumen	101	II		26 weeks	○**
Hegeman	32	II		1 year	○**
Hegeman	32	II	Function	6 weeks	○**
Hegeman	32	II		3 months	○**
Hegeman	32	II		1 year	○**

*comparing percutaneous pinning to casting ** comparing external fixation to casting
○: no significant difference

Supporting Evidence:

Evidence Tables 11 - 13 in supplemental evidence table document.

The amount of pain experienced after 1 year was not significantly different in patients treated with percutaneous pinning or with a cast (Figure 21). There was also no significant difference in overall mental or physical health as determined by the SF-36 score (Figure 22) and no significant difference in the occurrence of complications in patients treated with percutaneous pinning or cast (Table 27). However, percutaneous pinning does have complications that those patients treated with casts are not subject to (Table 28).

Both randomized controlled trials that compared patients treated with external fixation to those treated with cast and over the age of 55, found no statistically significant differences for pain experienced at different anatomic locations on or around the distal radius or with different amounts of activity after 1 year (Table 29 - Table 32). No statistically significant differences, for various functional activities, between patients treated with external fixation or casting and over the age of 55 were present after 1 year as well (Table 33 - Table 36).

Figure 21 Pain in patients over the age of 60 treated with percutaneous pinning or cast

Pain - VAS	SMD (95% CI)	N, mean (SD); Cast	N, mean (SD); Pinning
1 year	0.34 (-0.18, 0.86)	27, 1.2 (1.6)	30, .7 (1.3)

0

. Favors cast Favors pinning

Figure 22 SF-36 score in patients over the age of 60 treated with percutaneous pinning or cast

1 year	SMD (95% CI)	N, mean (SD); Pinning	N, mean (SD); Cast
SF-36 (mental)	0.05 (-0.47, 0.57)	30, 51 (13.2)	27, 50.4 (8.6)
SF-36 (physical)	0.38 (-0.15, 0.90)	30, 42.2 (9.7)	27, 38.2 (11.2)

0

. Favors cast Favors pinning

Table 27 Zero event complications in patients over the age of 60 treated with percutaneous pinning or cast

Study	Complications	Pinning n/N	Cast n/N	p-value*
Azzopardi	Loss of reduction	0/30	1/27	0.14
Azzopardi	Tendon injury	0/30	0/27	1.00
Azzopardi	Neurovascular injury	0/30	0/27	1.00

*test of arcsine difference, shaded cells indicates favored group if statistically significant

Table 28 Complications specific to percutaneous pinning

Study	Complications	Pinning n/N
Azzopardi	Infection of K-wire pin tract	1/30

Table 29 Radiocarpal pain in patients over the age of 55 after treatment with external fixation or cast

Study	Outcome	Duration	External fixation n/N	Cast n/N
Hegeman	Radiocarpal pain	6 weeks	9/15 patients	6/15 patients
Hegeman	Radiocarpal pain	3 months	6/15 patients	5/15 patients
Hegeman	Radiocarpal pain	1 year	2/15 patients	3/15 patients

Table 30 Radioulnar pain in patients over the age of 55 after treatment with external fixation or cast

Study	Outcome	Duration	External fixation n/N	Cast n/N
Hegeman	Radioulnar pain	6 weeks	9/15 patients	5/15 patients
Hegeman	Radioulnar pain	3 months	5/15 patients	5/15 patients
Hegeman	Radioulnar pain	1 year	2/15 patients	3/15 patients

Table 31 Ulnocarpal pain in patients over the age of 55 after treatment with external fixation or cast

Study	Outcome	Duration	External fixation n/N	Cast n/N

Hegeman	Ulnocarpal pain	6 weeks	9/15 patients	5/15 patients
Hegeman	Ulnocarpal pain	3 months	5/15 patients	5/15 patients
Hegeman	Ulnocarpal pain	1 year	2/15 patients	3/15 patients

Table 32 Pain in patients over the age of 55 after treatment with external fixation or cast

Study	Outcome	Duration	External fixation n/N	Cast n/N
Roumen	Continuous pain	26 weeks	1/21 patients	0/22 patients
Roumen	Pain on movement	26 weeks	2/21 patients	4/22 patients
Roumen	Pain on compression	26 weeks	6/21 patients	3/22 patients

Table 33 Functional difficulty (lifting light load) in patients over the age of 55 after treatment with external fixation or cast

Study	Outcome	Duration	External fixation n/N	Cast n/N
Hegeman	Difficulty lifting cup	6 weeks	11/15 patients	14/15 patients
Hegeman	Difficulty lifting cup	3 months	8/15 patients	3/15 patients
Hegeman	Difficulty lifting cup	1 year	1/15 patients	2/15 patients

Table 34 Functional difficulty (wringing) in patients over the age of 55 after treatment with external fixation or cast

Study	Outcome	Duration	External fixation n/N	Cast n/N
Hegeman	Difficulty wringing	6 weeks	13/15 patients	14/15 patients
Hegeman	Difficulty wringing	3 months	13/15 patients	11/15 patients
Hegeman	Difficulty wringing	1 year	8/15 patients	3/15 patients

Table 35 Functional difficulty (fine hand coordination) in patients over the age of 55 after treatment with external fixation or cast

Study	Outcome	Duration	External fixation n/N	Cast n/N
Hegeman	Difficult fine hand coordination	6 weeks	12/15 patients	14/15 patients

Hegeman	Difficult fine hand coordination	3 months	10/15 patients	3/15 patients
Hegeman	Difficult fine hand coordination	1 year	2/15 patients	5/15 patients

Table 36 Functional difficulty (heavy load bearing) in patients over the age of 55 after treatment with external fixation or cast

Study	Outcome	Duration	External fixation n/N	Cast n/N
Hegeman	Difficult heavy load bearing	6 weeks	12/15 patients	13/15 patients
Hegeman	Difficult heavy load bearing	3 months	12/15 patients	14/15 patients
Hegeman	Difficult heavy load bearing	1 year	9/15 patients	10/15 patients

RECOMMENDATION 6
We are unable to recommend for or against locking plates in patients over the age of 55 who are treated operatively.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

We were interested in determining the role of locking plates compared to other operative techniques in the potentially osteoporotic population. A single level II prospective non-randomized comparative cohort study addressed this recommendation by comparing volar locked plating with intrafocal pinning.[46] The inclusion criteria specified age over 60, but for consistency with other recommendations, this recommendation specifies patients aged 55 and older. No differences in complications were noted.

Supporting evidence:

Evidence Tables 14 - 15 in supplemental evidence table document.

Patients over the age of 60 and treated with volar locking plates or intrafocal pinning did not experience tendon rupture, osteomyelitis, cellulitis, or CRPS significantly more often compared to the other treatment (Table 37 and Table 38). However, patients treated with intrafocal pinning were subject to potential pin tract infections that patients treated with volar locking plates were not (Table 39).

Table 37 Complications in patients over the age of 60 treated with intrafocal pinning or volar locking plate

Complications	Intrafocal pinning n/N	Volar locking plate n/N	OR (95%CI)
Tendon rupture	2/31 patients	1/31 patients	2.07 (0.04, 5.62)

Table 38 Zero event complications in patients over the age of 60 treated with intrafocal pinning or volar locking plate

Study	Complications	Intrafocal pinning	Volar locking plate	p-value*

		n/N	n/N	
Oshige	Osteomyelitis	0/31	0/31	1.00
Oshige	Cellulitis	0/31	0/31	1.00
Oshige	CRPS	0/31	0/31	1.00

*test of arcsine difference, shaded cells indicates favored group if statistically significant

Table 39 Complications specific to operative intervention

Study	Complications	Intrafocal pinning n/N
Oshige	Infection of K-wire pin tract	4/31

RECOMMENDATION 7

We suggest rigid immobilization in preference to removable splints when using non-operative treatment for the management of displaced distal radius fractures.

Strength of Recommendation: Moderate

Description: Evidence from two or more "Moderate" strength studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.

Implications**:** Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.

Rationale:

For the purposes of this recommendation we considered rigid immobilization to be any form of immobilization that was firm (e.g. plaster, fiberglass) and not intended for self-removal, and less-rigid immobilization was any type of wrap or brace that either incompletely immobilized the wrist or was intended to be removed by the patient.

Five Level II randomized controlled trials met the inclusion criteria.[47-51] There were significant differences in pain at 5-6, 8 and 24 weeks in favor of casting. All other durations of follow-up did not have significant differences between patients treated with rigid immobilization or less-rigid immobilization. Radial nerve symptoms occurred more often in patients treated with less-rigid immobilization and no other complications were significantly different.

Table 40 Summary table for Recommendation 9

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored treatment
Tumia	182	II	Pain	10 days	○*
Moir	79	II		10 - 14 days	○*
Tumia	182	II		5 weeks	○*
Moir	79	II		5 - 6 weeks	cast*
Moir	79	II		8 weeks	cast*
Tumia	182	II		8 weeks	○*
Tumia	182	II		12 weeks	○*
Moir	79	II		13 weeks	○*
Tumia	182	II		24 weeks	cast*

Moir	79	II		26 weeks	○*
Moir	79	II	Complications	n/a	cast
Ledingham	57	II			
Bunger	136	II			
Stewart	235	II			

* reported by study author(s); ○: no significant difference

Supporting Evidence:

Evidence Tables 16 - 18 in supplemental evidence table document.

Patients treated with casting had less pain than those treated with braces at three different durations of follow-up (Table 41 and Table 42). There was only one significant difference in the occurrence of a complication in patients treated with cast and patients treated with braces. Only radial nerve symptoms occurred significantly more in patients treated with braces (Figure 23 and Table 43).

Table 41 Pain in patients with displaced DRF treated with cast or brace (Likert)

Study	Outcome	Duration	Cast	Brace
Tumia	Pain	10 days	1.8	2.1
Tumia	Pain	5 weeks	1.1	0.7
Tumia	Pain	8 weeks	1.2	1.2
Tumia	Pain	12 weeks	0.8	1.0
Tumia	Pain	24 weeks	0.5	0.8

Shaded cells indicate statistically significant differences identified by the study authors (ANOVA, $p < 0.05$)

Table 42 Pain in patients with displaced DRF treated with cast or brace (VAS)

Study	Outcome	Duration	Cast	Brace
Moir	Pain	10 - 14 days	3	4
Moir	Pain	5 - 6 weeks	1	2
Moir	Pain	8 weeks	1	2
Moir	Pain	13 weeks	1	1
Moir	Pain	26 weeks	0	1

Shaded cells indicate statistically significant differences identified by the study authors (t-test, $p < 0.05$)

Figure 23 Complications in patients with displaced DRF treated with cast or brace

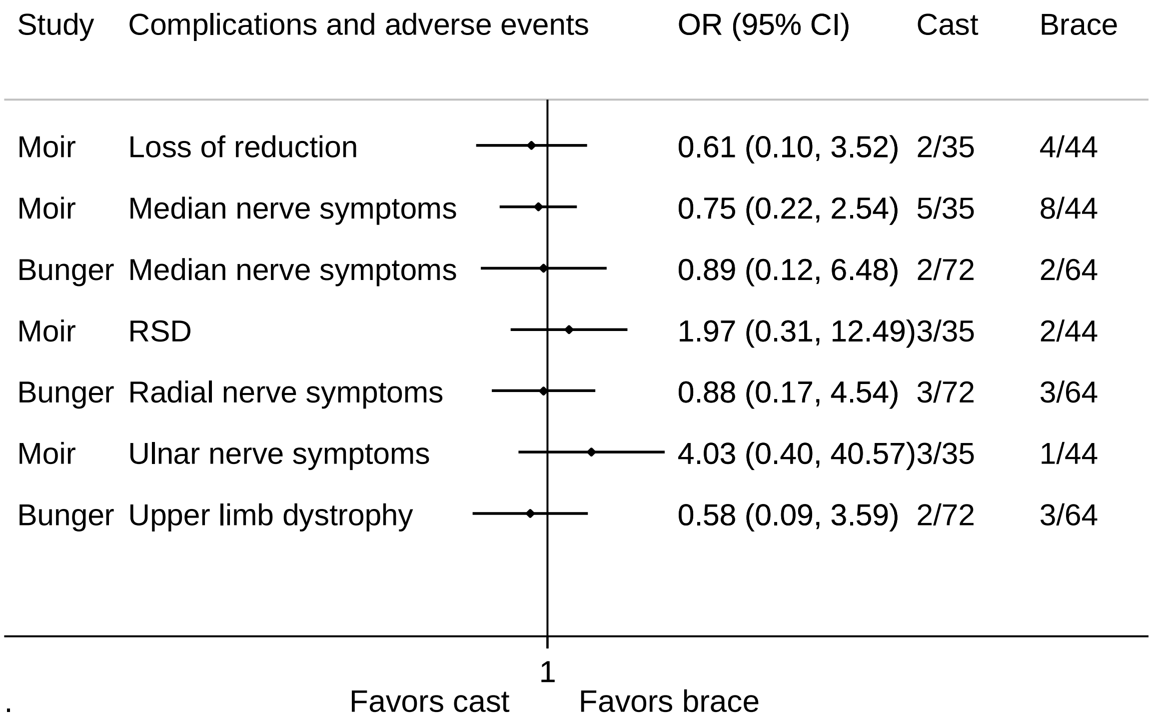


Table 43 Zero event complications in patients with displaced DRF treated with cast or brace

Study	Complications	Cast n/N	Brace n/N	p-value*
Ledingham	RSD	0/28	0/29	1.00
Stewart	RSD	0/93	0/142	1.00
Moir	Radial nerve symptoms	0/35	3/44	0.02
Stewart	Radial nerve symptoms	0/93	0/142	1.00
Ledingham	Radial nerve symptoms	0/28	6/29	0.000
Ledingham	Shoulder hand syndrome	0/28	0/29	1.00
Stewart	Shoulder stiffness	0/93	0/142	1.00
Ledingham	Tendon rupture	1/27	0/29	0.15
Stewart	Tendon rupture	1/92	0/142	0.12

*test of arcsine difference, shaded cells indicates favored group if statistically significant

RECOMMENDATION 8

The use of removable splints is an option when treating minimally displaced distal radius fractures.

Strength of Recommendation: Limited

Description: Evidence from two or more "Low" strength studies with consistent findings, or evidence from a single "Moderate" quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

Rationale:

For the purposes of this recommendation minimal displacement was defined as acceptable alignment after the initial injury and prior to any reduction. Rigid immobilization was any form of immobilization that was firm (e.g. plaster, fiberglass) and not intended for self-removal, and less-rigid immobilization was any type of wrap or brace that either incompletely immobilized the wrist or was intended to be removed by the patient.

Four clinical trials that compared cast to splint treatment met the inclusion criteria. [47, 52-54] All had at least one methodological flaw and were downgraded to Level II. There were no age criteria.

Pain at 2 weeks was significantly lower in casted patients in one of 4 trials. Pain at six or eight weeks was significantly lower in splinted patients in 2 of 4 trials. This resulted in the downgrading of the recommendation to "Limited." All other durations of follow-up did not have significant differences between patients treated with less-rigid immobilization or rigid immobilization.

Table 44 Summary table for Recommendation 8

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored treatment
O'Connor	66	II	Pain	1 week	○
Tumia	147	II		10 days	○
Abbaszadegan	68	II		11 days	○
O'Connor	66	II		2 weeks	cast
Davis	52	II		4 weeks	○
Abbaszadegan	68	II		4 weeks	○
Tumia	147	II		5 weeks	○
O'Connor	66	II		6 weeks	brace
Davis	52	II		6 weeks	○
Abbaszadegan	68	II		8 weeks	brace*
Tumia	147	II		8 weeks	○
Tumia	147	II		12 weeks	○
Tumia	147	II		24 weeks	○
Abbaszadegan	68	II		1 year	○
Davis	52	II	Function	> 5 weeks	○
O'Connor	66	II	Complications	n/a	○
Tumia	147	II			
Abbaszadegan	68	II			
Davis	52	II			

* reported by study author(s); ○: no significant difference

Supporting Evidence:

Evidence Tables 19 - 21 in supplemental evidence table document.

Pain experienced by patients treated with cast was significantly less at 2 weeks when compared to those treated with a brace (Figure 24). At mid-term durations of follow-up (6-8 weeks), significantly less pain was experienced by patients treated with a brace (Figure 24 and Table 45). At long-term durations of follow-up there was no significant difference in the amount of pain experienced by patients treated with either cast or brace (Table 45 and Table 46). Function in these patients was similar for all tasks except fork/knife use (Table 47). There were no complications that occurred significantly more in patients treated with casts. Only ulnar nerve symptoms occurred significantly more in patients treated with a brace (Figure 25 and Table 48).

Figure 24 Pain in patients with minimally displaced DRF treated with cast or brace

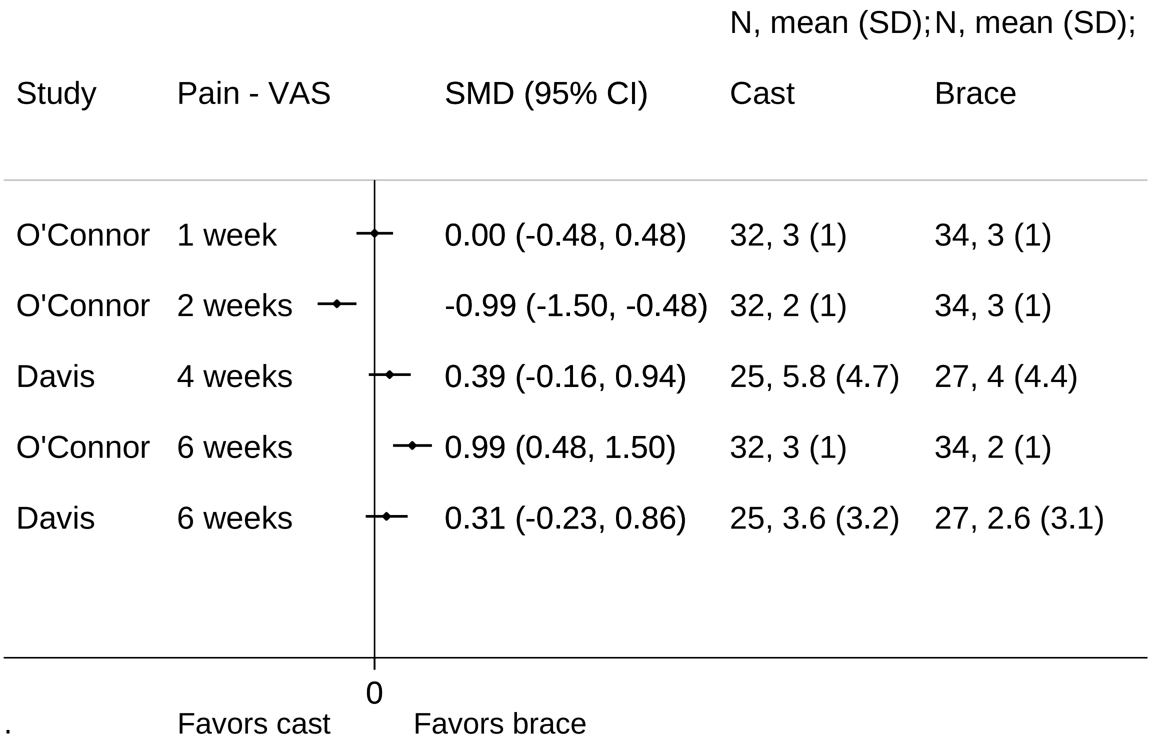


Table 45 Pain in patients with minimally displaced DRF treated with cast or brace (VAS)

Study	Outcome	Duration	Cast	Brace
Abbaszadegan	Pain	11 days	4.7	4.0
Abbaszadegan	Pain	4 weeks	3.7	3.4
Abbaszadegan	Pain	8 weeks	3.2	1.8
Abbaszadegan	Pain	1 year	1.9	1.3

*shaded cell indicates significant difference reported by the study authors

Table 46 Pain in patients with minimally displaced DRF treated with cast or brace (Likert)

Study	Outcome	Duration	Cast	Brace
Tumia	Pain	10 days	1.8	2.1
Tumia	Pain	5 weeks	1.1	0.7
Tumia	Pain	8 weeks	1.2	1.2
Tumia	Pain	12 weeks	0.8	1.0
Tumia	Pain	24 weeks	0.5	0.8

Table 47 Functional abilities in patients with minimally displaced DRF treated with cast or brace

Study	Outcome	Cast n/N	Brace n/N
Davis	Can handle coin	24/25 patients	23/27 patients
Davis	Use knife/fork	15/25 patients	27/27 patients
Davis	Use a can opener	22/25 patients	23/27 patients
Davis	Can turn a key	24/25 patients	26/27 patients
Davis	Can carry shopping bag	16/25 patients	19/27 patients

*shaded cell indicates significant difference reported by the study authors

Figure 25 Complications in patients with minimally displaced DRF treated with cast or brace

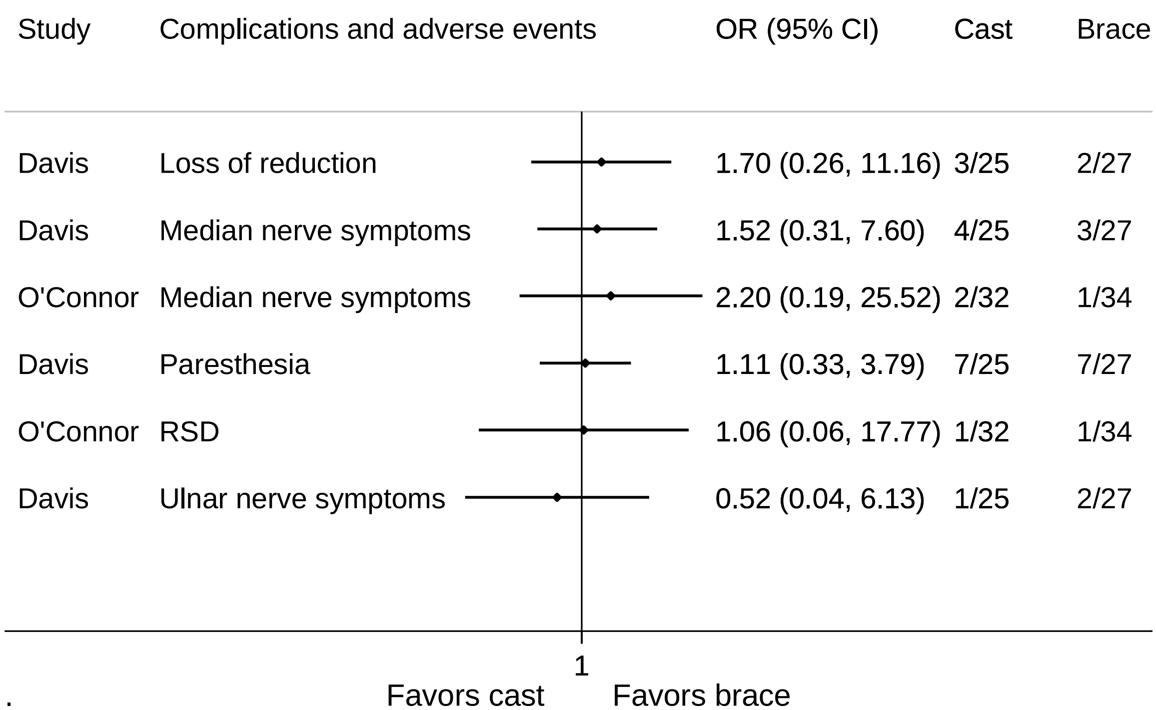


Table 48 Zero event complications in patients with minimally displaced DRF treated with cast or brace

Study	Complications	Cast n/N	Brace n/N	p-value*
Abbaszadegan	CTS	0/34	1/34	0.16
Davis	Shoulder stiffness	0/25	1/27	0.16
Davis	Tendon rupture	1/25	0/27	0.15
O'Connor	Ulnar nerve symptoms	0/32	2/34	0.05

*test of arcsine difference, shaded cells indicates favored group if statistically significant

RECOMMENDATION 9

We are unable to recommend for or against immobilization of the elbow in patients treated with cast immobilization

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

For the purposes of this recommendation we considered immobilization of the elbow as immobilization of forearm rotation (pronation and supination).

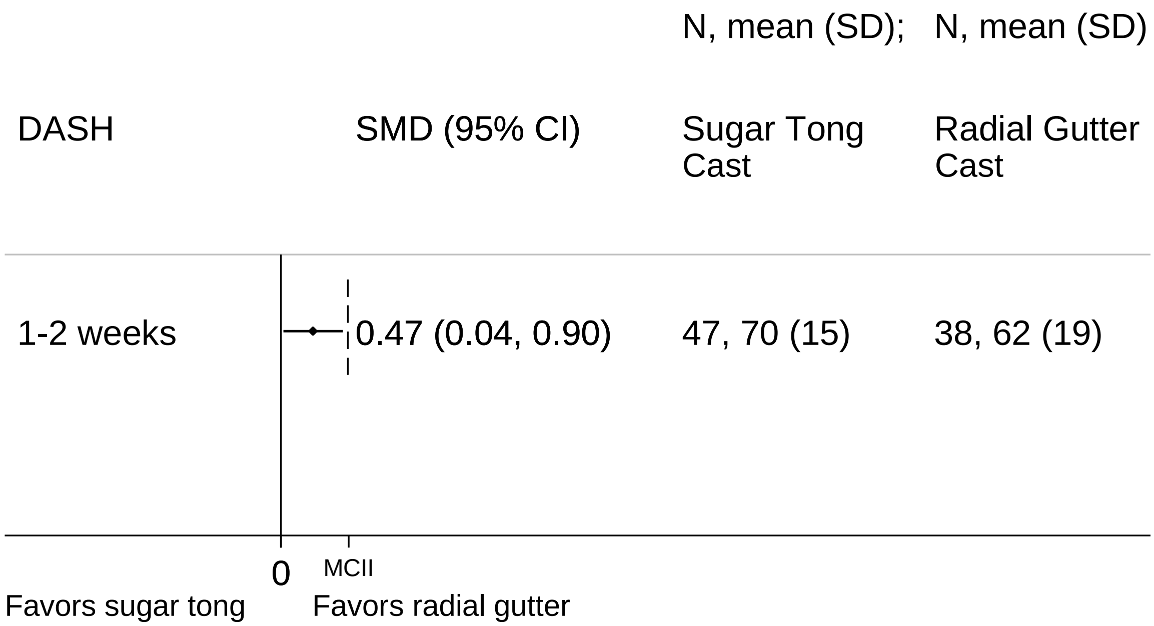
One randomized controlled trial compared above elbow to below elbow splinting for maintenance of reduction for 2 weeks after manipulative reduction of unstable fracture and found no differences.[55] No other outcomes were assessed.

Supporting Evidence:

Evidence Tables 22 - 24 in supplemental evidence table document.

There appears to be no clinically important difference between patients treated with a sugar tong cast and those treated with a radial gutter cast (Figure 26).

Figure 26 DASH score in patients with displaced DRF treated with sugar tong cast or radial gutter cast



RECOMMENDATION 10

Arthroscopic evaluation of the articular surface is an option during operative treatment of intra-articular distal radius fractures.

Strength of Recommendation: Limited

Description: Evidence from two or more "Low" strength studies with consistent findings, or evidence from a single "Moderate" quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

Rationale:

There were two studies that met the inclusion criteria[56, 57] but only one was sufficiently powered to detect the minimal clinically important difference.[56] In this study, arthroscopy assisted reduction of the articular surface. In the arthroscopy group the DASH scores were clinically improved at the three month interval. Regardless of arthroscopy, the difference in function as determined by DASH scores was inconclusive at 1 and 2 years postoperatively. This resulted in a downgrading of the recommendation to "Limited."

Table 49 Summary table for Recommendation 10

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored treatment
Varitimidis	40	II	Function	3 months	Arthroscopic*
Varitimidis	40	II		12 months	inconclusive
Varitimidis	40	II		24 months	inconclusive

* clinically important difference compared to fluoroscopic

Supporting Evidence:

Evidence Tables 25 - 27 in supplemental evidence table document.

See Figure 27 and Figure 28 next page.

Figure 27 DASH score in patients treated with arthroscopy or fluoroscopy (RCT)

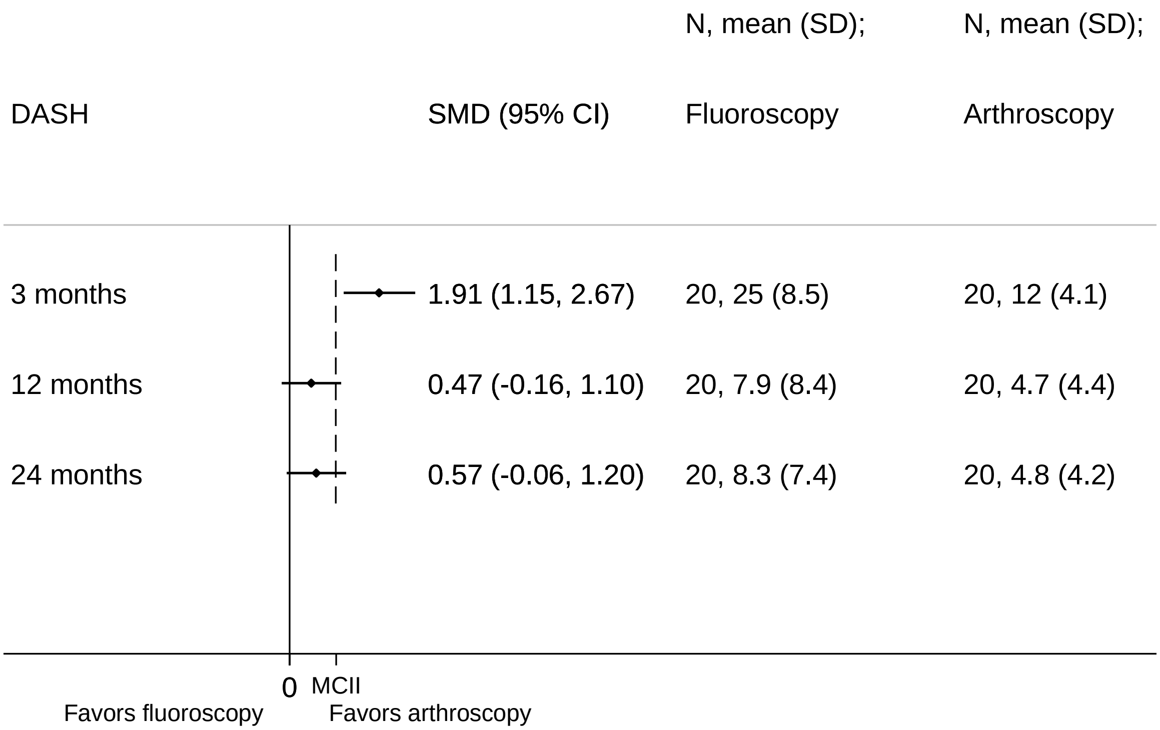
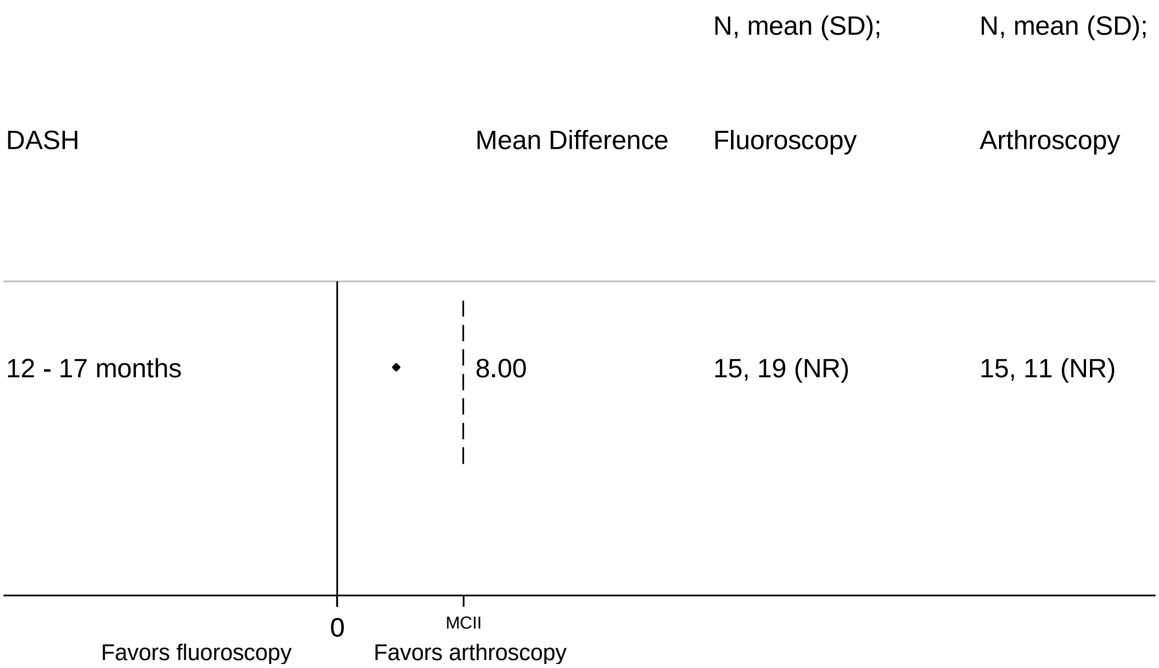


Figure 28 DASH score in patients treated with arthroscopy or fluoroscopy (cohort)



The author's of this study report no statistically significant difference (t-test, $p > .05$). The study was not powered to detect the MCII of the DASH instrument

RECOMMENDATION 11

Operative treatment of associated ligament injuries (SLIL injuries, LT, or TFCC tears) at the time of radius fixation is an option.

Strength of Recommendation: Limited

Description: Evidence from two or more "Low" strength studies with consistent findings, or evidence from a single "Moderate" quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

Rationale:

There was one Level II trial that compared the arthroscopic reduction and fixation of distal radius fracture combined with arthroscopic treatment of associated intra carpal ligament and TFCC injuries to fluoroscopic reduction and fixation of the radius alone.[55] The authors demonstrated that arthroscopy is a valuable adjunctive method for evaluating and treating these lesions which are not detectable on standard radiographs. One limitation of the study is the possibility of preexisting carpal lesions. An additional limitation is that the true incidence of carpal ligament lesions in the fluoroscopy group was unknown. These limitations resulted in a downgrading of the recommendation to "Limited." In the arthroscopy group, the DASH scores were clinically important at the three month interval. Regardless of arthroscopy, the difference in function as determined by DASH scores was inconclusive at 1 and 2 years postoperatively.

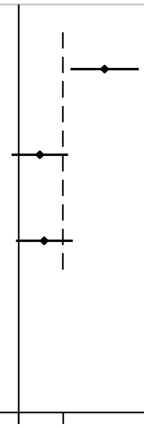
Supporting Evidence:

Evidence Tables 28 - 30 in supplemental evidence table document.

The RCT investigating the comparison between patients treated with fluoroscopic assisted reduction and fixation and arthroscopic assisted reduction and fixation in Recommendation 10 is applicable to this recommendation. Patients treated with arthroscopic assisted reduction and fixation received treatment for their associated ligament injuries. Patients treated with fluoroscopic assisted reduction and fixation did not. However, the prevalence of ligament injuries in the patients treated with arthroscopic assisted reduction and fixation is 75% and the existence of ligament injuries in the fluoroscopic assisted reduction and fixation patients was not reported. The results of this study are presented in Figure 29.

Figure 29 DASH score in patients treated for ligament injury or not receiving treatment of ligament injury

DASH		SMD (95% CI)	N, mean (SD); No treatment	N, mean (SD); Treatment of Ligament Injuries
3 months		1.91 (1.15, 2.67)	20, 25 (8.5)	20, 12 (4.1)
12 months		0.47 (-0.16, 1.10)	20, 7.9 (8.4)	20, 4.7 (4.4)
24 months		0.57 (-0.06, 1.20)	20, 8.3 (7.4)	20, 4.8 (4.2)



0 MCII

Favors no treatment Favors treatment of ligamnet injuries

RECOMMENDATION 12

Arthroscopy is an option in patients with distal radius intra articular fractures to improve diagnostic accuracy for wrist ligament injuries, and CT is an option to improve diagnostic accuracy for patterns of intra-articular fractures.

Strength of Recommendation: Limited

Description: Evidence from two or more "Low" strength studies with consistent findings, or evidence from a single "Moderate" quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

Rationale:

Arthroscopy can improve the evaluation of carpal ligament lesions but the included studies did not demonstrate the effect of this on patient outcome.[58, 59] The single study on the use of CT scanning demonstrated better fracture characterization but did not associate these findings with improved outcome.[60] Based on the lack of patient treatment outcome and concerns regarding the additional costs, the recommendation was downgraded to "Limited."

Supporting Evidence:

Evidence Tables 31 - 33 in supplemental evidence table document.

Direct visualization of additional fracture lines and ligament injuries is the gold standard in distal radius fractures. We identified one study that investigated the diagnostic accuracy of CT with direct visualization as the gold standard that met our inclusion criteria. The effectiveness of CT as determined by the likelihood ratios suggest that CT provides small but sometimes important changes in the probability of detecting distal radius fracture characteristics (Table 50).

The use of arthroscopy to assess additional fracture lines or ligament injuries in distal radius fractures was investigated in two prospective cohort studies. Arthroscopy was effective in detecting ligament injuries and additional fracture lines not seen with plain radiography (Table 51 - Table 55).

There were no studies identified that investigated the effectiveness of MRI compared to the gold standard of direct visualization that met our inclusion criteria.

Table 50 Effectiveness of radiographs plus CT in determining intra-articular fracture characteristics

Study	N	Injury	Diagnostic modality	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Harness	100	Coronal fracture line	x-ray plus 2D CT	1.85 (1.15, 2.99)	0.34 (0.19, 0.61)	0.81 (0.7, 0.89)	0.57 (0.34, 0.77)
Harness	100	Coronal fracture line	x-ray plus 3D CT	1.64 (1.07, 2.52)	0.36 (0.19, 0.68)	0.82 (0.72, 0.9)	0.5 (0.28, 0.72)
Harness	100	Coronal fracture line	x-ray plus 2D/3D CT	1.95 (1.15, 3.29)	0.24 (0.12, 0.48)	0.87 (0.77, 0.93)	0.56 (0.31, 0.78)
Harness	100	Articular depression	x-ray plus 2D CT	1.96 (1.23, 3.14)	0.42 (0.26, 0.68)	0.74 (0.61, 0.83)	0.63 (0.44, 0.79)
Harness	100	Articular depression	x-ray plus 3D CT	2.01 (1.21, 3.36)	0.49 (0.32, 0.75)	0.67 (0.55, 0.78)	0.67 (0.48, 0.82)
Harness	100	Articular depression	x-ray plus 2D/3D CT	2.53 (1.36, 4.7)	0.47 (0.32, 0.69)	0.65 (0.53, 0.76)	0.74 (0.55, 0.88)
Harness	100	Articular comminution	x-ray plus 2D CT	2.12 (1.3, 3.48)	0.38 (0.23, 0.62)	0.75 (0.64, 0.85)	0.65 (0.45, 0.81)
Harness	100	Articular comminution	x-ray plus 3D CT	2.77 (1.45, 5.3)	0.35 (0.22, 0.55)	0.75 (0.63, 0.84)	0.73 (0.52, 0.88)
Harness	100	Articular comminution	x-ray plus 2D/3D CT	2.8 (1.49, 5.27)	0.26 (0.15, 0.45)	0.82 (0.71, 0.9)	0.71 (0.49, 0.87)

Table 51 Prevalence of additional fracture lines detected by arthroscopy of intra-articular fractures

Study	Original fracture classification	n/N fractures with additional fracture line	Prevalence
Richards	Styloid	2/13	**15%**
Richards	Three-part	10/32	**31%**
Richards	Four-part	0/41	**0%**
Richards	Volar Smith	1/2	**50%**
Richards	Total	13/88	**15%**

Table 52 Prevalence of TFCC tears detected by arthroscopy of intra-articular fractures

Study	Associated injury	Prevalence	n/N
Geissler	TFCC tear*	**43%**	26/60
	Palmer Type A	50%	13/26
	Palmer Type B	27%	7/26
	Palmer Type D	23%	6/26
Richards	TFCC tear*	**35%**	31/88
	Palmer Type A	13%	4/31
	Palmer Type B	26%	8/31
	Palmer Type D	61%	19/31

Table 53 Prevalence of scapholunate tears detected by arthroscopy of intra-articular fractures

Study	Associated injury	Prevalence	n/N
Geissler	Scapholunate tear	**32%**	19/60
	Grade II	53%	10/19
	Grade III	37%	7/19
	Grade IV	10%	2/19
Richards	Scapholunate tear	**26%**	23/88
	Central	17%	4/23
	Volar	35%	8/23
	Complete	48%	11/23

Table 54 Prevalence of lunotriquetral interosseous ligament tears detected by arthroscopy of intra-articular fractures

Study	Associated injury	Prevalence	n/N
Geissler	Lunotriquetral interosseous ligament tear	**15%**	9/60
	Grade II	22%	2/99
	Grade III	78%	7/9
Richards	Lunotriquetral interosseous ligament tear	**7%**	6/88
	Volar	17%	1/6
	Complete	83%	5/6

Table 55 Prevalence of concurrent soft tissue injuries detected by arthroscopy of intra-articular fractures

Study	Associated injury	Prevalence	n/N
Geissler	Concurrent soft tissue injuries	**22%**	13/60
	TFCC + scapholunate	54%	7/13
	TFCC + lunotriquetral	23%	3/13
	scapholunate + lunotriquetral	23%	3/13
Richards	Concurrent injury of scapholunate + lunotriquetral	**6%**	5/88

RECOMMENDATION 13

We are unable to recommend for or against the use of supplemental bone grafts or substitutes when using locking plates.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

There were no qualified studies identified that addressed this recommendation.

Supporting Evidence:

Evidence Table 34 in supplemental evidence table document.

There were no studies investigating patients undergoing open reduction and internal fixation with a locking plate with supplemental bone graft that and met our inclusion criteria.

RECOMMENDATION 14

We are unable to recommend for or against the use of bone graft (autograft or allograft) or bone graft substitutes for the filling of a bone void as an adjunct to other operative treatments.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

We were interested in determining the role of bone void fillers in addition to operative fracture fixation. Only one study compared the use of allograft versus autograft after dorsal plating.[61] No difference in pain or function was observed. They did however report complications related to autograft harvestation.

Several studies suggest some benefit related to pain reduction when calcium phosphate is used to support fixation.[62-67] These studies did not compare the outcome of fixation with and without the material and hence are not applicable to this recommendation. We cannot support or discredit the use of bone substitutes as an adjunct to operative fixation.

Supporting Evidence:

Evidence Tables 35 - 38 in supplemental evidence table document.

There was no significant difference in the number of patients that experienced pain or restricted activities of daily living when treated with adjunct autograft or allograft for dorsal plating (Table 56). There were however, several unique complications related to the autograft donor site (Table 57).

Table 56 Pain and activities of daily living in patients treated with adjunct autograft or allograft

Study	Outcome	Autograft n/N	Allograft n/N
Rajan	No or mild pain	39/46	40/44
Rajan	Intense or discomforting pain	7/46	4/44

Rajan	no or slight restriction on activities of daily living	40/46	39/44
Rajan	severe or moderate restriction on activities of daily living	6/40	5/44

Table 57 Complications specific to autograft donor site

Study	Complications	Autograft n/N
Rajan	Hematoma	8/46
Rajan	Infection	1/46
Rajan	Seroma	2/46
Rajan	Tear of spina iliaca	1/46
Rajan	Meralgia paraesthetica	6/46

RECOMMENDATION 15

In the absence of reliable evidence, it is the opinion of the work group that distal radius fractures that are treated non-operatively be followed by ongoing radiographic evaluation for 3 weeks and at cessation of immobilization.

Strength of Recommendation: Consensus

Description: The supporting evidence is lacking and requires the work group to make a recommendation based on expert opinion by considering the known potential harm and benefits associated with the treatment. A **Consensus** recommendation means that expert opinion supports the guideline recommendation even though there is no available empirical evidence that meets the inclusion criteria of the guideline's systematic review.

Implications: Practitioners should be flexible in deciding whether to follow a recommendation classified as **Consensus,** although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.

Rationale:

Redisplacement during non-operative treatment of distal radius fractures may result in symptomatic malunions in any patient. The work group deemed that it is warranted to issue a recommendation on this topic despite a lack of evidence determining maintenance of adequate fracture reduction during non-operative treatment. Patients and surgeons may agree to alter treatment if the fracture is noted to lose reduction during this period. This recommendation will involve patient visits and radiographic assessment which is part of orthopedic care of these injuries. We believe that such monitoring of fracture position during non-operative treatment is consistent with the current practice of most orthopedic surgeons.

RECOMMENDATION 16

We are unable to recommend whether two or three Kirschner wires should be used for distal radius fracture fixation.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

There were no qualified studies identified that addressed this recommendation.

Supporting Evidence:

Evidence Table 40 in supplemental evidence table document.

There were no studies comparing patients treated with two or three pins for fixation of distal radius fracture.

RECOMMENDATION 17

We are unable to recommend for or against using the occurrence of distal radius fractures to predict future fragility fractures.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

Our intent was to investigate if there is an association between distal radius fractures and future fragility fractures. Based upon our evaluation of the likelihood ratio data, the evidence for this association was inconclusive.

Supporting Evidence:

Evidence Tables 41 - 43 in supplemental evidence table document.

We identified six prospective cohort studies reporting the occurrence of fragility fractures after distal radius fracture that met our inclusioncriteria.[68-73] The likelihood ratios for the included studies have conflicting results. 1 of the 6 studies suggests that a distal radius fracture generates small but sometimes important changes in the probability of a future fragility fracture. The other five studies suggest that distal radius fracture alters the probability of a future fragility fracture to a small and rarely important degree (Table 58). Additionally, a diagnostic meta-analysis of the ability of distal radius to predict a future hip fracture shows low sensitivity and high specificity for distal radius fracture in predicting future fragility fracture (Figure 30).

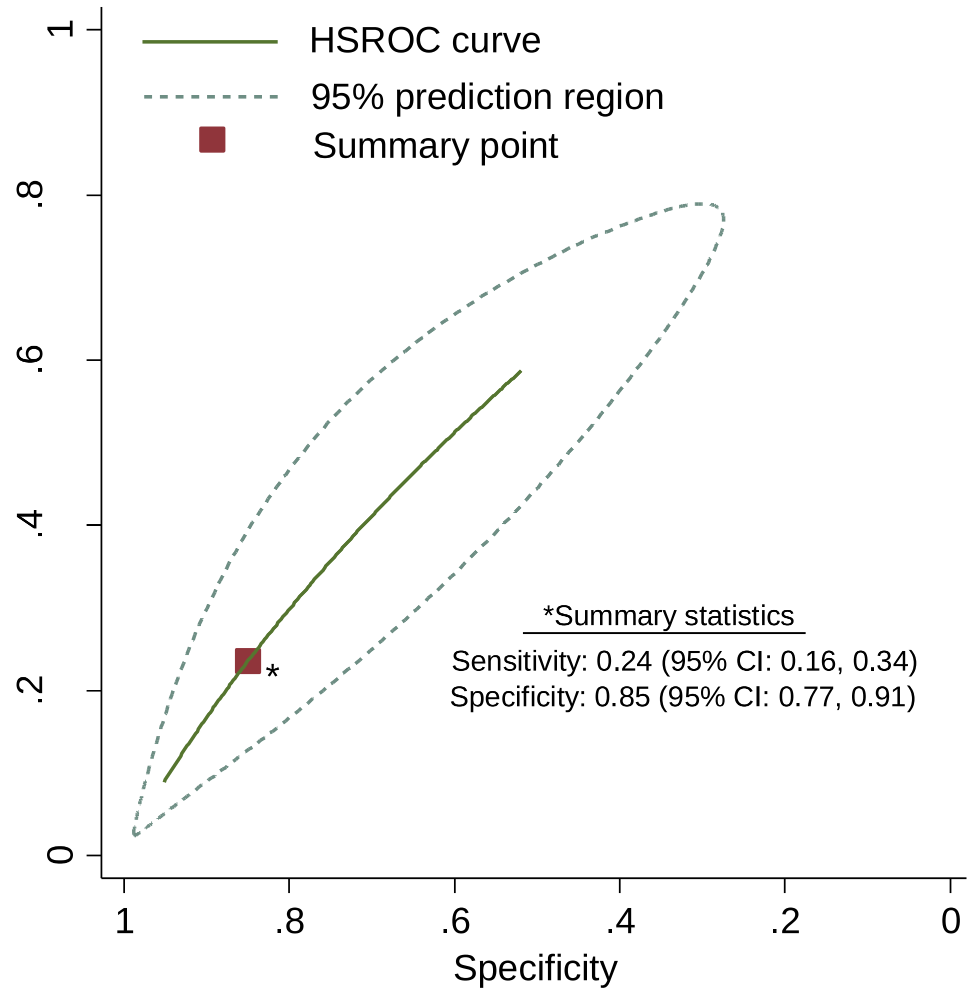
Table 58 Sensitivity and specificity of individual studies of DRF determining subsequent osteoporotic fragility fracture

Study	N	Age limit for incident DRF	Subsequent fracture	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Gunnes	29802	25	hip	1.7 (1.56, 1.86)	0.83 (0.79, 0.86)	0.34 (0.31, 0.37)	0.8 (0.8, 0.81)
Mallmin	2676	40	hip	1.27 (1.16, 1.39)	0.75 (0.66, 0.86)	0.61 (0.56, 0.66)	0.52 (0.5, 0.54)
Barrett-Connor	158940	45	hip	2.76 (2.31, 3.3)	0.9 (0.87, 0.93)	0.15 (0.12, 0.18)	0.95 (0.95, 0.95)
Cooper	900	50	hip	1.85 (1.28, 2.67)	0.92 (0.87, 0.97)	0.16 (0.12, 0.21)	0.91 (0.89, 0.93)
Schousboe	7427	NR	hip	1.1 (0.93, 1.31)	0.98 (0.95, 1)	0.17 (0.14, 0.2)	0.85 (0.84, 0.85)
Gunnes	29802	25	spine	1.51 (1.39, 1.64)	0.87 (0.84, 0.9)	0.3 (0.28, 0.32)	0.8 (0.8, 0.81)
Barrett-Connor	158940	45	spine	1.62 (1.27, 2.07)	0.96 (0.94, 0.99)	0.09 (0.07, 0.11)	0.95 (0.95, 0.95)
Schousboe	7214	NR	spine	1.29 (1.03, 1.63)	0.95 (0.91, 1)	0.18 (0.14, 0.23)	0.86 (0.85, 0.87)
Gardsell	1076	NR	all**	1.36 (1.1, 1.68)	0.86 (0.81, 0.97)	0.33 (0.27, 0.39)	0.76 (0.73, 0.79)
Barrett-Connor	158940	45	any*	2.85 (2.65, 3.07)	0.9 (0.89, 0.91)	0.15 (0.14, 0.16)	0.95 (0.95, 0.95)

* includes hip and spine fractures above in addition to wrist, forearm, and rib

** hip, spine, radius, humerus, tibial

Figure 30 Hierarchical summary ROC meta-analysis of the sensitivity and specificity of DRF in determining future hip fracture



RECOMMENDATION 18

We are unable to recommend for or against concurrent surgical treatment of distal radioulnar joint instability in patients with operatively treated distal radius fractures.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

We were interested in determining whether early surgical treatment of DRUJ instability performed at the same time as operative treatment of acute distal radius fractures provides improved patient outcomes. Two studies were found that investigated the functional outcome of DRUJ injuries. [74, 75] The instabilities were identified at the conclusion of treatment. Therefore no instabilities were treated at the time of surgery. Although the patients with instability had poorer outcomes, neither study addressed the question of whether early operative intervention is indicated.

Table 59 Summary table for Recommendation 18

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored group
Lindau	76	II	Pain	1 year	Stable DRUJ
Roysam	170	III		6 weeks	No DRUJ Involvement
Roysam	170	III		6 months	No DRUJ Involvement
Roysam	170	III		1 year	No DRUJ Involvement

Supporting Evidence:

Evidence Tables 44 - 46 in supplemental evidence table document.

We identified one prospective non-randomized study compared patients with unstable DRUJ after distal radius fixation to patients with a stable DRUJ after distal radius fixation that met our inclusion criteria. Patients with unstable DRUJ had significantly more pain at rest and on loading than those patients with a stable DRUJ (Figure 31).

We also identified an additional prospective non-randomized study comparing patients with a distal radius fracture involving the DRUJ to those with a fracture not involving the DRUJ that met our inclusion criteria. Significantly more patients without involvement of the DRUJ were pain free 6 weeks after treatment of their distal radius fracture (Figure 32). The authors report that this significant difference remained at 6 months and 1 year (chi-square, $p < 0.05$).

Figure 31 Pain in patients with unstable DRUJ or stable DRUJ concurrent to DRF

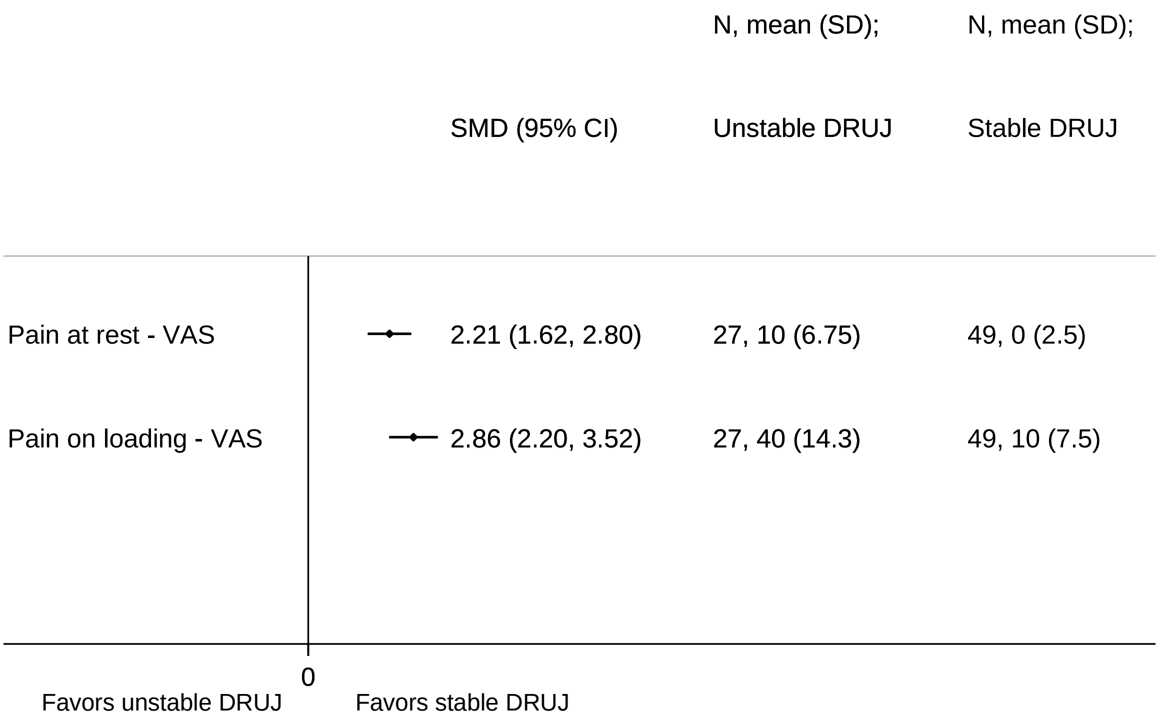
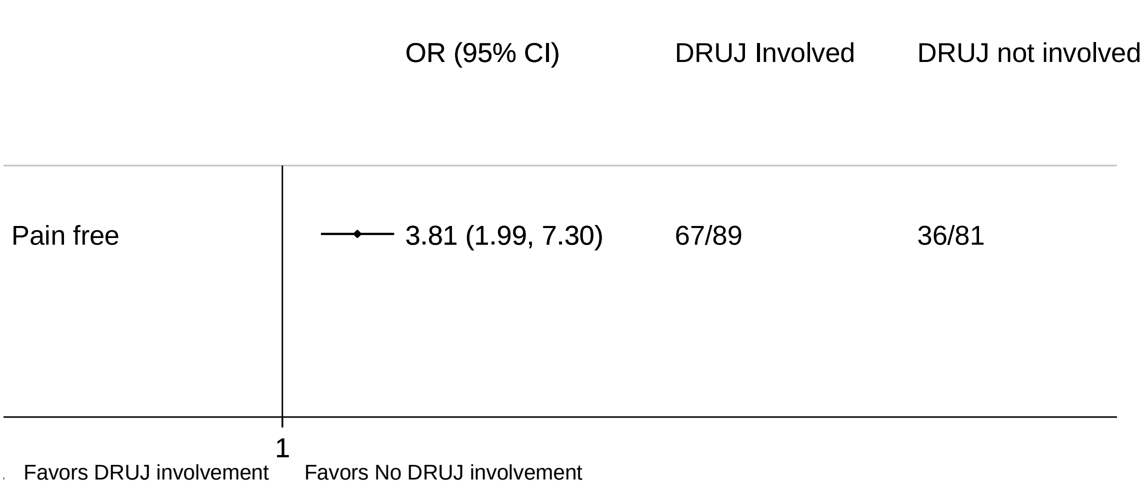


Figure 32 Pain free patients with DRUJ involved or not involved DRF



RECOMMENDATION 19

We suggest that all patients with distal radius fractures receive a post-reduction true lateral x-ray of the carpus to assess DRUJ alignment.

Strength of Recommendation: Moderate

Description: Evidence from two or more "Moderate" strength studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.

Implications: Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.

Rationale:

It is common knowledge that in the presence of a DRUJ injury or distal radius fracture the injury itself can preclude identifying DRUJ dislocation. In order to not miss this treatable injury which often occurs in association with distal radius fractures, we were interested in determining whether true lateral x-rays can identify DRUJ dislocation. Two studies addressed this question.[76, 77] One study described the piso-scaphoid distance and the other studied scaphoid/lunate/triquetrum overlap. Because both of these studies are based on level II evidence and showed that accurately performed lateral x-rays can reliably identify DRUJ dislocation when associated with DRF, we made the recommendation that true lateral x-rays be obtained in patients with distal radius fractures.

Table 60 Summary table for Recommendation 19

Study	N	X-ray measurement	Summary
Nakamura	36	difference between pisoscaphoid distance of uninjured wrist and injured wrist < 3mm with > 5mm radioulnar distance injured wrist	Large and often conclusive change in probability of DRUJ subluxation or dislocation
Nakamura	20	difference between pisoscaphoid distance of uninjured wrist and injured wrist > 4mm with > 5mm radioulnar distance injured wrist	Small - moderate change in probability of DRUJ subluxation or dislocation
Mino	15	complete superimposition of the proximal pole of the scaphoid on the lunate and triquetrum without complete ulnar overlap	Moderate change in probability of DRUJ subluxation or dislocation

Supporting Evidence:

Evidence Tables 47 - 49 in supplemental evidence table document.

We identified two prospective cohort studies examining the effectiveness of lateral x-rays in the assessment of DRUJ alignment that met our inclusion criteria. Sensitivity, specificity, and positive and negative likelihood ratios of three different assessment methods are listed in Table 61.

Table 61 Sensitivity and specificity of individual studies studying lateral x-rays for determination of DRUJ alignment

Study	N	X-ray measurement	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Nakamura	36	difference between pisoscaphoid distance of uninjured wrist and injured wrist < 3mm with > 5mm radioulnar distance injured wrist	10.21 (2.7, 38.6)	0.08 (0.01, 0.52)	0.93 (0.66, 1)	0.91 (0.71, 0.99)
Nakamura	20	difference between pisoscaphoid distance of uninjured wrist and injured wrist > 4mm with > 5mm radioulnar distance injured wrist	2.73 (1.06, 7)	0.14 (0.02, 0.93)	0.91 (0.59, 1)	0.67 (0.3, 0.93)
Mino	15	complete superimposition of the proximal pole of the scaphoid on the lunate and triquetrum without complete ulnar overlap	6 (0.39, 92.28)	0.55 (0.27, 1.09)	0.5 (0.16, 0.84)	1 (0.48, 1)

RECOMMENDATION 20

In the absence of reliable evidence, it is the opinion of the work group that all patients with distal radius fractures and unremitting pain during follow-up be re-evaluated.

Strength of Recommendation: Consensus

Description: The supporting evidence is lacking and requires the work group to make a recommendation based on expert opinion by considering the known potential harm and benefits associated with the treatment. A **Consensus** recommendation means that expert opinion supports the guideline recommendation even though there is no available empirical evidence that meets the inclusion criteria of the guideline's systematic review.

Implications: Practitioners should be flexible in deciding whether to follow a recommendation classified as **Consensus,** although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.

Rationale:

The pain associated with a distal radius fracture will typically diminish after standard treatment protocols. Patient's reports of unremitting pain during the early treatment period may signal a concomitant associated condition which requires investigation. The work group deemed that it is warranted to issue a recommendation on this topic despite the lack of evidence to support or refute the investigation into the source of unremitting pain following treatment of distal radius fracture. Each patient in the treatment of distal radius fracture should report their progress in recovery. When pain levels do not decrease as expected, it is appropriate to evaluate the patient for causes of pain. This recommendation may result in costs associated with assessment and management. We believe these actions are consistent with the current practice of most orthopedic surgeons

RECOMMENDATION 21
A home exercise program is an option for patients prescribed therapy after distal radius fracture.

Strength of Recommendation: Limited

Description: Evidence from two or more “Low” strength studies with consistent findings, or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

Rationale:

We were interested in determining the role of formal therapy compared to non-formal therapy after distal radius fracture. Five randomized controlled trials compared a directed home exercise program against various forms of supervised therapy.[78-82] All had at least one methodological flaw and were considered level II evidence.

In 4 of the 5 studies, patients were treated with casting (with or without addition of pins) and therapy was started after removal of fixation (cast or external fixator). In one study, all patients were treated by volar plating and therapy was commenced 1 week postoperatively.

In studies comparing directed home exercise program to supervised therapy started after removal of fixation there was no difference in pain or function. We questioned the applicability of these studies because of the timing of therapy. In the remaining study where patients were mobilized 1 week after plating, the home exercise group had significantly better functional (PRWE) scores than the group that received formal therapy. The strength of recommendation was graded as “limited” based on the possibly clinically important effects identified by this study.

The above studies excluded, by design, patients with complications (finger stiffness, CRPS) and the data above reflect the effect of therapy in radius fractures that were healing without any adverse events.

Table 62 Summary table for Recommendation 21

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored treatment
Kay 2000	39	II	Function	3 weeks	○
Kay 2000	39	II		6 weeks	○
Krischak	46	II		6 weeks	advice/exercises**
Maciel	35	II		6 weeks	true negative
Maciel	33	II		24 weeks	true negative
Kay 2000	39	II	Pain	3 weeks	○
Maciel	35	II		6 weeks	○
Kay 2000	39	II		6 weeks	○
Wakefield	96	II		6 weeks	○
Wakefield	90	II		3 months	○
Maciel	33	II		24 weeks	○
Wakefield	66	II		6 months	○

** possibly clinically important difference compared to supervised hand therapy;
○: no significant difference

Supporting Evidence:

Evidence Tables 51 - 54 in supplemental evidence table document.

Patients that did not receive any formal treatment from a hand therapist had significantly more pain and significantly decreased function after 3 weeks of therapy than patients that received home based therapy exercise with the advice of a physical therapist. At 6 weeks patients that did not receive any formal treatment from a hand therapist had significantly more pain and the difference in function did not remain statistically significant (**Error! Reference source not found.**).

Patients treated with home based therapy exercise with the advice of a physical therapist had no difference in the amount of pain or reduction in function (as determined by the PRWE instrument or VAS) compared to those patients treated by supervised hand therapy (Figure 33 - Figure 35).

Figure 33 PRWE score in patients treated with supervised hand therapy or advice/exercise hand therapy

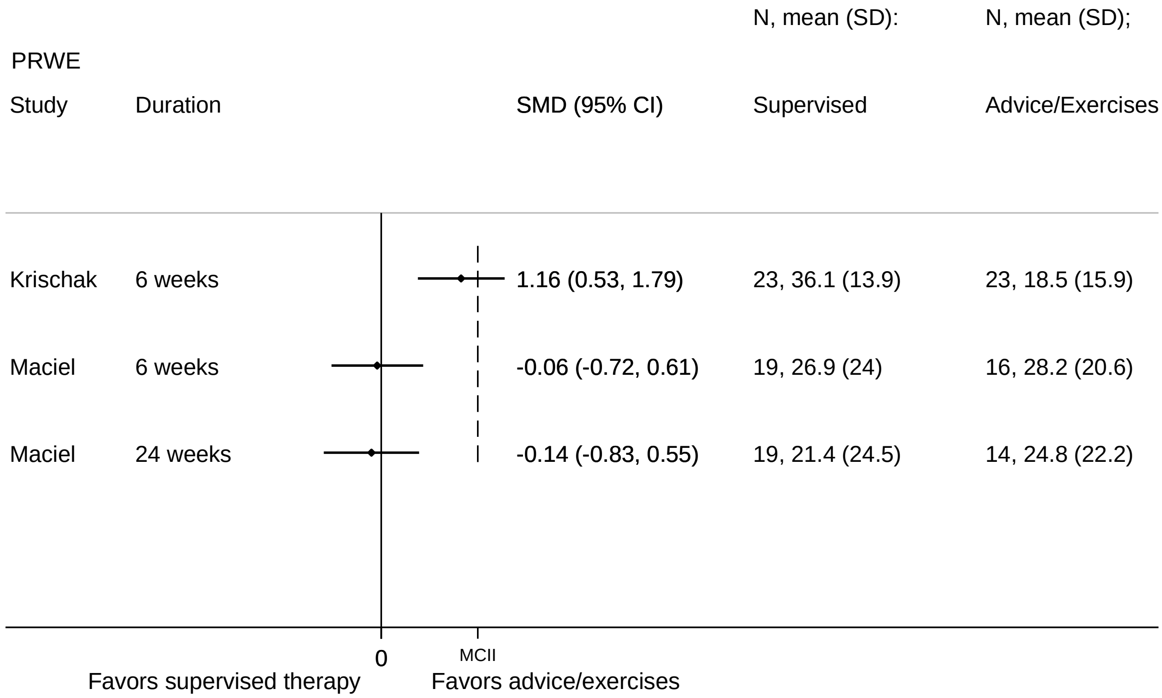


Figure 34 PRWE subscale score in patients treated with supervised hand therapy or advice/exercise hand therapy

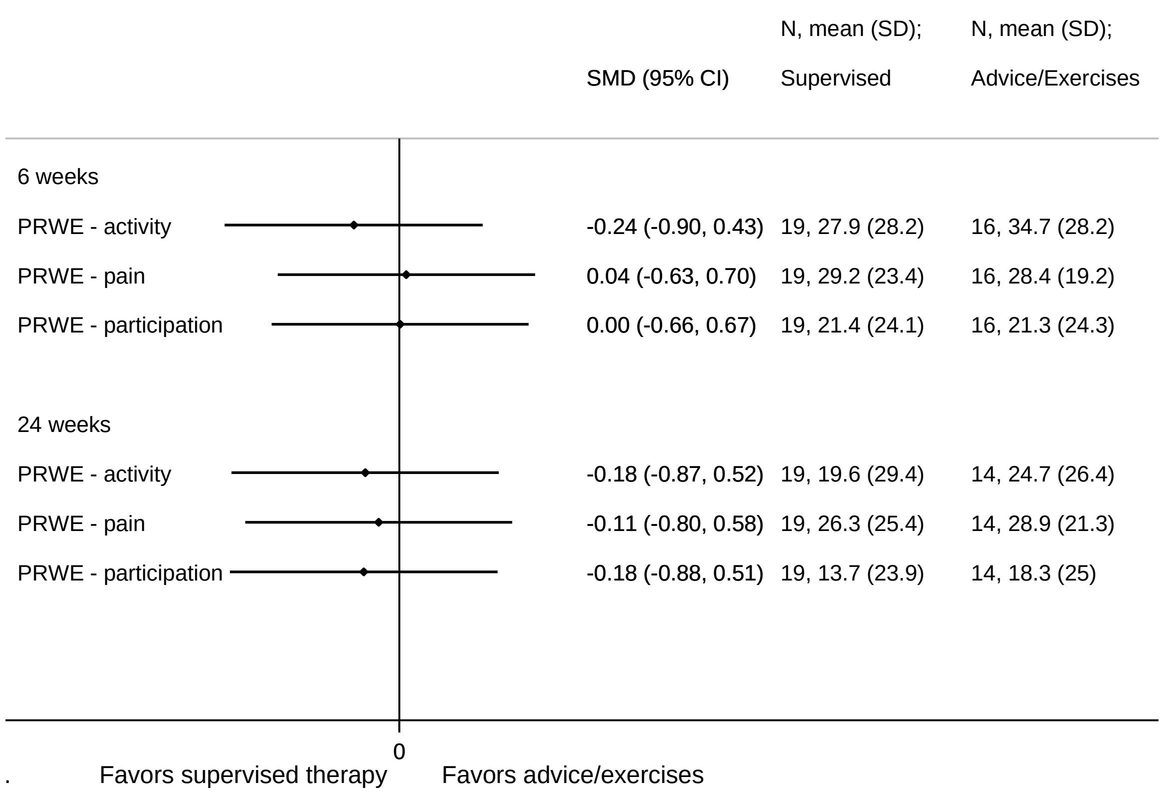
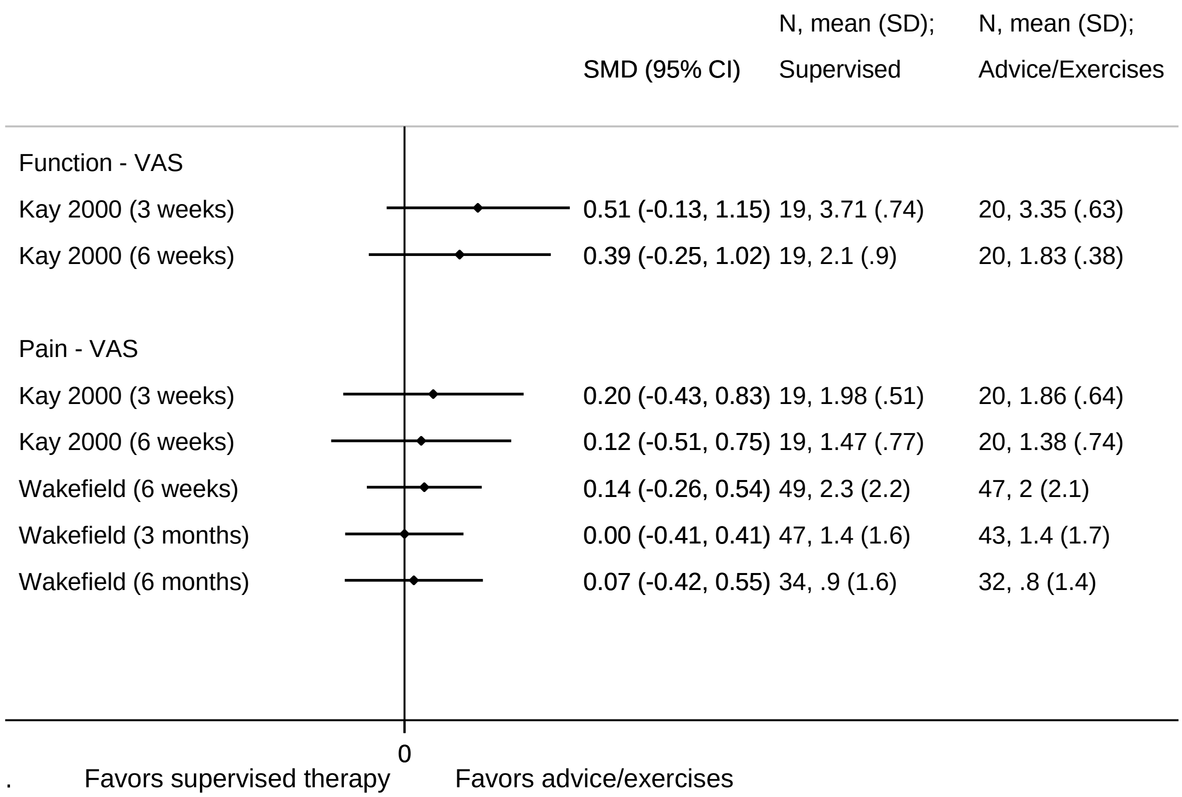


Figure 35 Pain and function in patients treated with supervised hand therapy or advice/exercise hand therapy



RECOMMENDATION 22

In the absence of reliable evidence, it is the opinion of the work group that patients perform active finger motion exercises following diagnosis of distal radius fractures.

Strength of Recommendation: Consensus

Description: The supporting evidence is lacking and requires the work group to make a recommendation based on expert opinion by considering the known potential harm and benefits associated with the treatment. A **Consensus** recommendation means that expert opinion supports the guideline recommendation even though there is no available empirical evidence that meets the inclusion criteria of the guideline's systematic review.

Implications: Practitioners should be flexible in deciding whether to follow a recommendation classified as **Consensus,** although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.

Rationale:

Hand stiffness is one of the most functionally disabling adverse effects after distal radius fractures. Stiffness of the fingers can result from a combination of factors including pain, swelling, obstruction by splints or casts, and apprehension or lack of understanding by the patient. Finger stiffness can be very difficult to treat after fracture healing requiring multiple therapy visits and possibly additional surgical intervention. Instructing the patient at the first encounter to move their fingers regularly and through a complete range of motion may help to minimize the risk of this complication. Finger motion does not have any adverse effects on an adequately stabilized distal radius fracture with regard to reduction or healing. This is an extremely cost-effective intervention as it does not require any pharmaceutical intervention or additional visits while making a significant impact on patient outcome. Although finger stiffness is a critical adverse effect of distal radius fractures and directly impacts patient outcome, the effects of early finger motion cannot be ethically evaluated in a level I prospective study. The members of the work group feel it is important to make a recommendation by consensus opinion.

It is current clinical practice for the treating physician to instruct every patient to move their fingers after distal radius fracture regardless of the type of treatment or immobilization selected. This recommendation is consistent with current practice.

RECOMMENDATION 23

We suggest that patients do not need to begin early wrist motion routinely following stable fracture fixation.

Strength of Recommendation: Moderate

Description: Evidence from two or more “Moderate” strength studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention. A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.

Implications: Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.

Rationale:

Three studies were included in this recommendation.[25, 83, 84] Each study investigated different operative treatment methods: volar plate, trans-styloid fixation or external fixation. Mobilization was commenced at different times, in the two internal fixation studies, therapy was started approximately at 1 week and in the external fixation study, mobilization was commenced at 3 weeks. In 2 studies, the control group was either casted or immobilized with a fixator. In the volar plating study, the control group was immobilized by a thermoplastic splint that they were instructed to remove for showering and therefore are not a reliable control group.

The outcome measures used were pain and function (DASH) and/or complications. None of the outcomes were significantly different between early motion and late motion. These data support the recommendation that patients do not need to begin early wrist motion after stable fracture fixation.

Table 63 Summary table for Recommendation 23

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored group
Allain	60	II	Pain	4 weeks	○
Lozano-Calderon	56	II		3 months	true negative
Lozano-Calderon	54	II		6 months	true negative
Allain	60	II		1 year	○
Lozano-Calderon	56	II	Function	3 months	○
Lozano-Calderon	54	II		6 months	○
Lozano-Calderon	56	II	Complications	n/a	○
Allain	60	II			○

McQueen	54	II			○

○: no significant difference

Supporting Evidence:

Evidence Tables 56 - 58 in supplemental evidence table document.

There is no difference (true negative) in function determined by the DASH score up to 6 months, between patients with early wrist motion and those with late wrist motion (Figure 36). There is also no significant difference between the amount of pain experienced by patients with early wrist motion compared to those with late wrist motion (Figure 37 and Figure 38). No significant differences in the occurrence of complications between patients with early wrist motion or late wrist motion were seen in any of the trials (Figure 39 and Table 64).

Figure 36 DASH score in patients with early or late wrist motion

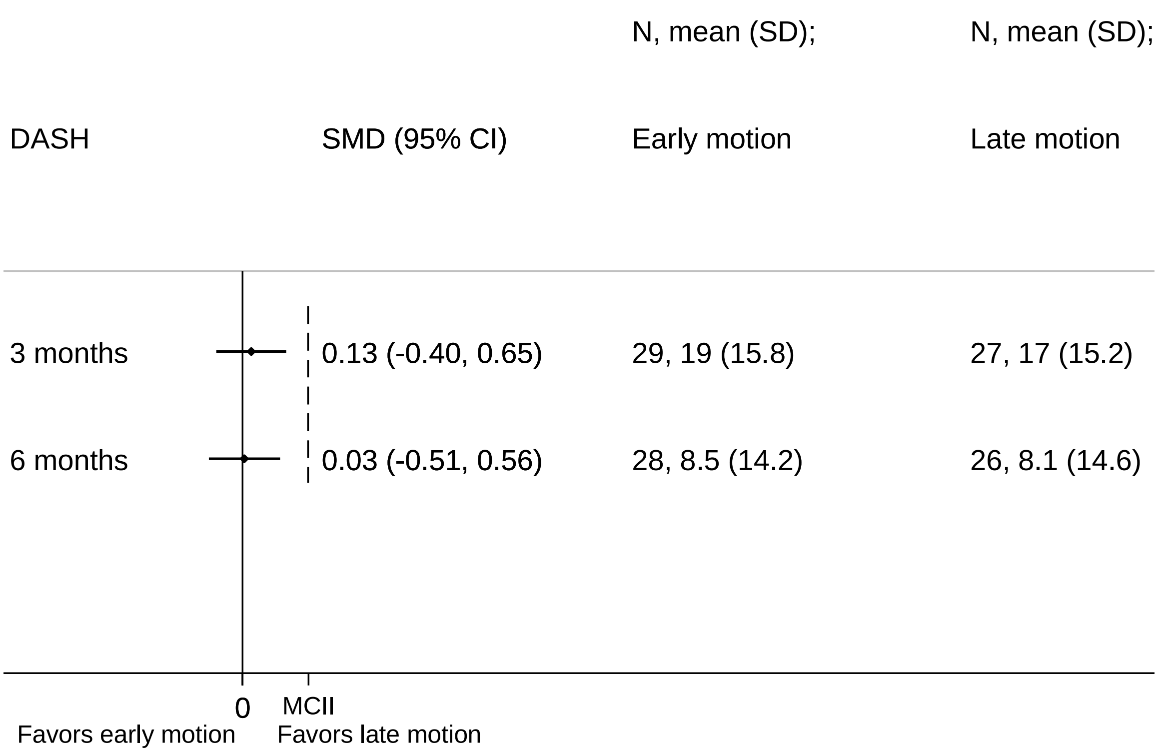


Figure 37 Pain (ordinal scale) in patients with early or late wrist motion

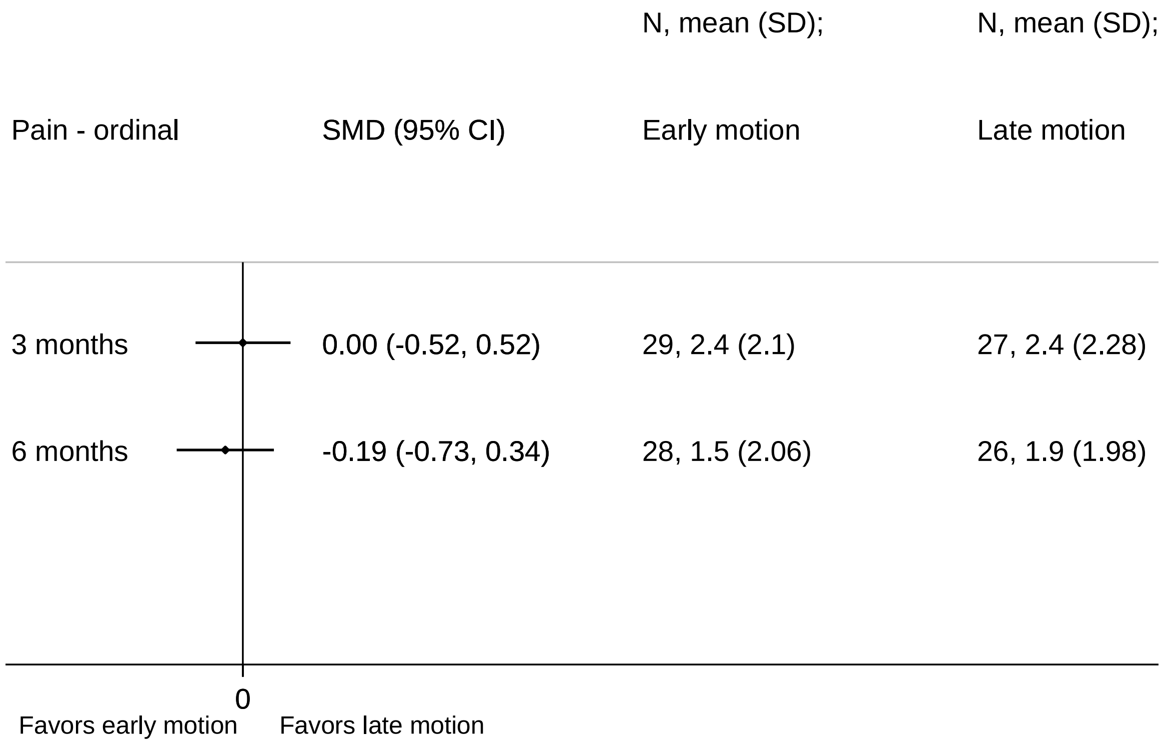
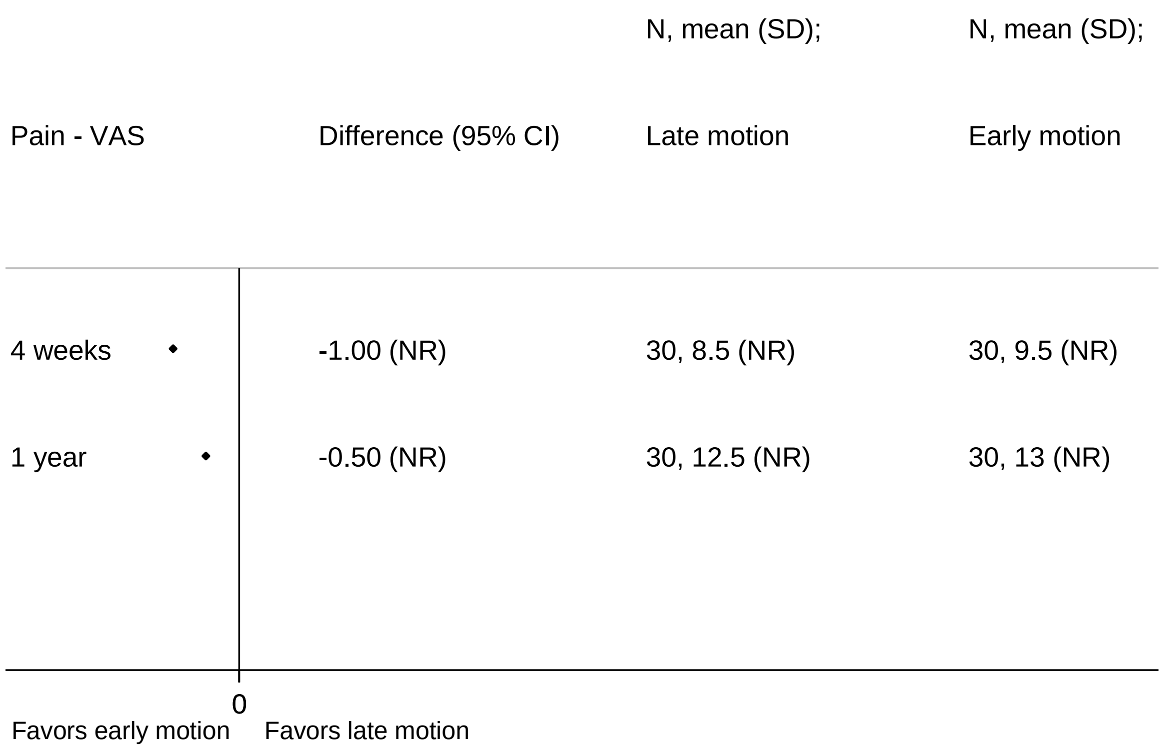


Figure 38 Pain on VAS in patients with early or late wrist motion



The study authors report these differences are not statistically significant (t-test, p<0.05)

Figure 39 Complications in patients with early or late wrist motion

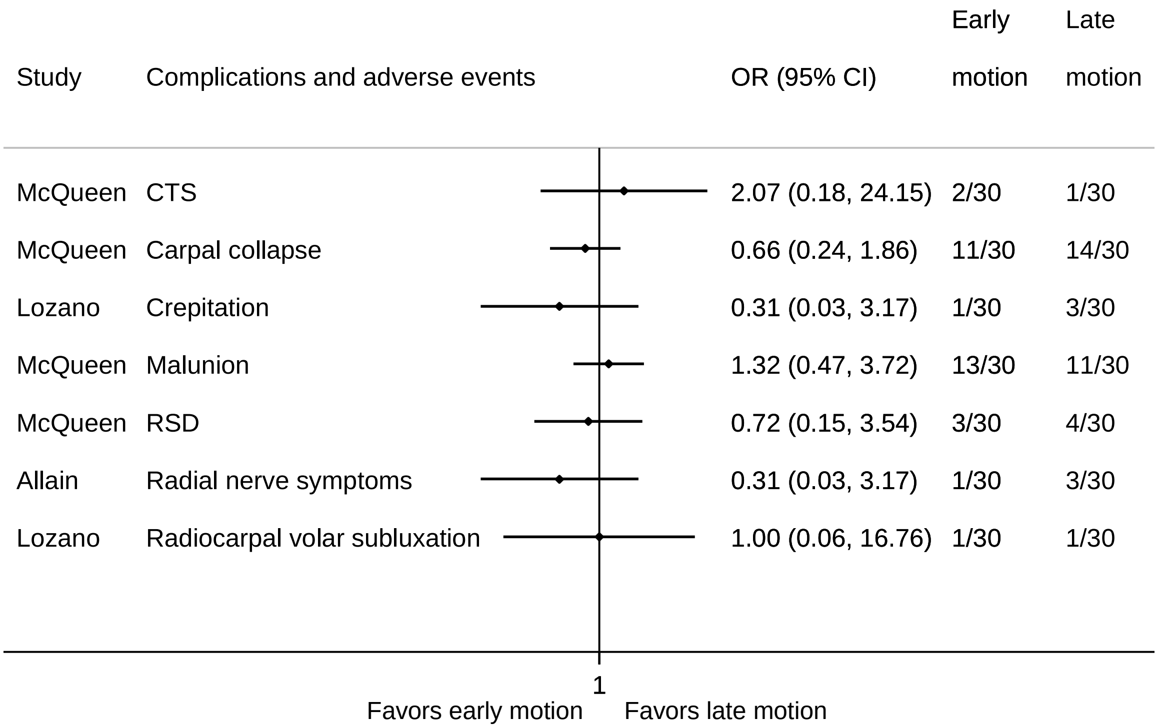


Table 64 Zero event complications in patients with early or late wrist motion

Study	Complications	Early motion n/N	Late motion n/N	p-value*
Lozano	CTS	1/30	0/30	0.16
Allain	Deep infection	0/30	0/30	1.00
Allain	Migrated pin	0/30	1/30	0.16
McQueen	Neurapraxia	0/30	1/30	0.16
Lozano	Plate removal	0/30	1/30	0.16
Allain	RSD	1/30	0/30	0.16
Allain	Tendon Rupture	0/30	1/30	0.16
McQueen	Tendon Rupture	0/30	0/30	1.00
Lozano	Wound/superficial infection	1/30	0/30	0.16
Allain	Wound/superficial infection	1/30	0/30	0.16
McQueen	Wound/superficial infection	0/30	0/30	1.00

*test of arcsine difference, shaded cells indicates favored group if statistically significant

RECOMMENDATION 24

In order to limit complications when using external fixation, it is an option to limit the duration of fixation.

Strength of Recommendation: Limited

Description: Evidence from two or more "Low" strength studies with consistent findings, or evidence from a single "Moderate" quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

Rationale:

Three prospective studies met the inclusion criteria. These studies, collectively, do not agree upon a length of immobilization and we chose not to define a specific duration. The first study demonstrated no significant difference in groups treated with external fixation for 5 weeks as compared to 3 weeks of external fixation and 2 weeks of additional casting.[85] The results were reported using a non-validated patient outcome score, hence no clear effect could be demonstrated by the early discontinuation of the external fixation. Two additional studies using a non-validated patient outcome score showed a statistically significant association between outcomes and prolonged external fixation.[86, 87] Based on limitations of the outcome instruments, the strength of recommendation was graded as "Limited."

Supporting Evidence:

Evidence Tables 59 - 62 in supplemental evidence table document.

Figure 40 shows the results comparing durations of treatment and Table 65 reports the results of the regression analysis performed by the study authors.

Figure 40 Solgaard score in patients treated with external fixation for 3 or 5 weeks

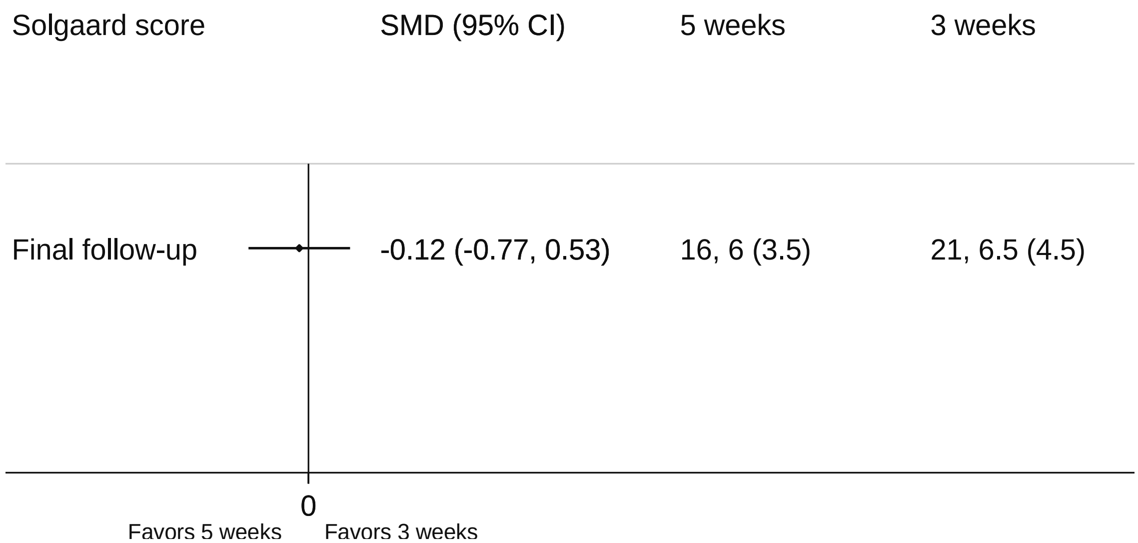


Table 65 Effect of duration of external fixation on NYOH wrist score

Study	Regression coefficient	p-value
Kaempffe and Walker, 2000	not reported	0.0003
Kaempffe, et al., 1993	-0.54	0.01

RECOMMENDATION 25

We are unable to recommend against over-distraction of the wrist when using an external fixator.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

Two level II studies met the inclusion criteria. [86, 87] There was no statistically significant association between the amount of distraction and patient outcome using a non-validated instrument. However, the work group agreed that the important potential adverse effect of finger stiffness was not evaluated in these studies. It would not be ethical to conduct a prospective study to examine the effect of over-distraction. The work group hence have downgraded the recommendation to “inconclusive”.

Supporting Evidence:

Evidence Tables 63 and 64 in supplemental evidence table document.

RECOMMENDATION 26

We suggest adjuvant treatment of distal radius fractures with Vitamin C for the prevention of disproportionate pain.

Strength of Recommendation: Moderate

Description: Evidence from two or more "Moderate" strength studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention. A **Moderate** recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the strength of the supporting evidence is not as strong.

Implications: Practitioners should generally follow a **Moderate** recommendation but remain alert to new information and be sensitive to patient preferences.

Rationale:

We were interested in determining the potential benefit of nutritional supplements in recovery of function after treatment of distal radius fractures. Two studies that met our inclusion criteria examined the use of Vitamin C.[88, 89] Specifically, the studies found a significant reduction in the incidence of complex regional pain syndrome after treatment of distal radius fracture when the patients were given supplemental Vitamin C. These studies have a serious limitation. The final outcome measure of CRPS is ordinarily difficult to define objectively. The authors used subjective criteria to define pain syndrome in these studies and hence the reliability of the data is limited. We have hence downgraded the recommendation to "Moderate."

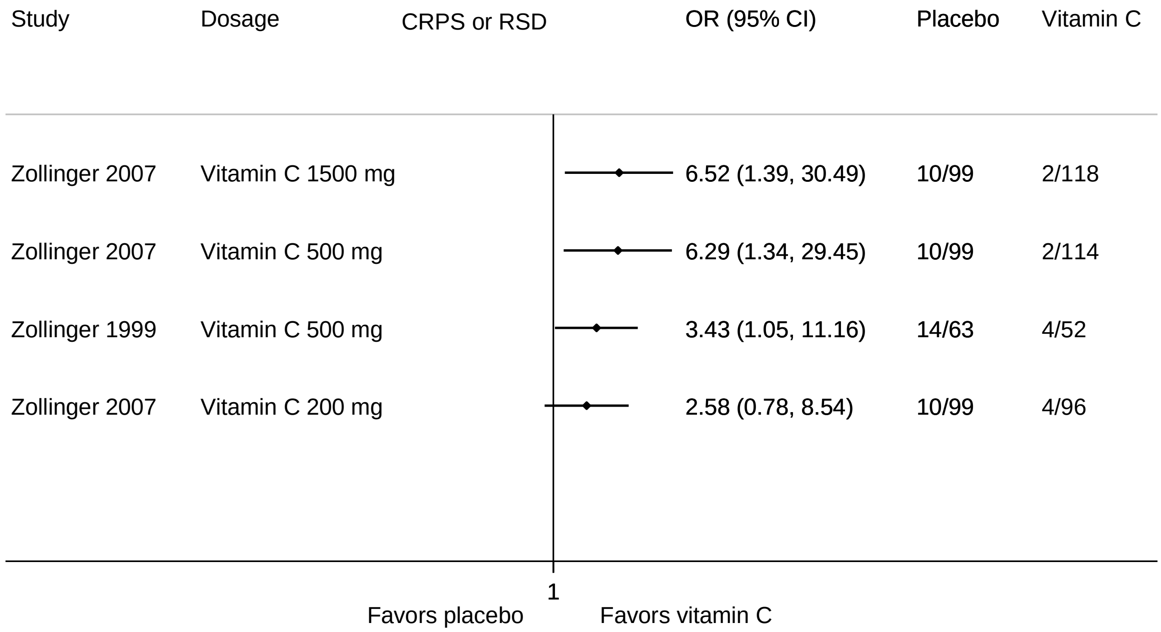
Supporting Evidence:

Evidence Tables 65 - 67 in supplemental evidence table document.

One study compared placebo to vitamin C dosages of 200, 500, or 1500 mg daily and the other study compared placebo to vitamin C dosage of 500 mg daily. The number of patients that developed complex regional pain syndrome (CRPS) (otherwise known as reflex sympathetic dystrophy (RSD) or algodystrophy) suggests statistically significant association between vitamin C dosages above 500 mg daily with reduced occurrence of CRPS (Figure 41). The earlier study enrolled only patients treated conservatively for their distal radius fractures while the recent trial enrolled some patients that received operative treatment of their distal radius fractures (11% of patients were treated operatively).

There were no studies investigating other medications, vitamins, or mineral adjuvant treatments (e.g. vitamin B, Vitamin D, calcium, phosphates) that met our inclusion criteria.

Figure 41 CRPS (or RSD) in patients treated with adjuvant vitamin C or placebo



RECOMMENDATION 27

Ultrasound and/or ice are options for adjuvant treatment of distal radius fractures.

Strength of Recommendation: Limited

Description: Evidence from two or more "Low" strength studies with consistent findings, or evidence from a single "Moderate" quality study recommending for or against the intervention or diagnostic. A **Limited** recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

Implications: Practitioners should be cautious in deciding whether to follow a recommendation classified as **Limited**, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

Rationale:

We included two studies that used non-validated patient outcome measures. The study examining the effect of low-intensity ultrasound reported statistically significant improvement in number of patients with no pain and radiographic union; however no long term or permanent benefit related to a validated outcome measure was demonstrated with the use of low-intensity ultrasound.[90] The second study demonstrated the value of ice at 3 and 5 days but no benefit for pulsed electromagnetic field therapy (PEMF).[91] The additional cost of ultrasound along with the less reliable evidence resulted in the downgrading of this recommendation to "Limited."

Table 66 Summary table for Recommendation 27

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored adjuvant
Kristiansen	61	II	Time to healing	n/a	ultrasound
Kristiansen	61	II	Healing	6 weeks	ultrasound
Kristiansen	61	II		8 weeks	ultrasound
Kristiansen	61	II		10 weeks	ultrasound
Kristiansen	61	II		12 weeks	ultrasound
Cheing	38	II	Pain	3 days	ice
Cheing	38	II		5 days	ice

Supporting Evidence:

Evidence Tables 68 - 70 in supplemental evidence table document.

In the trial investigating low-intensity ultrasound there was a statistically significant reduction in time to healing for patients treated with ultrasound, as well as a statistically significant number of patients with healed fractures at several follow-up durations (Figure 42, Figure 43). The outcomes investigated in this study suggest an increased rate of healing (as determined by absence of pain and radiographic union).

The trial investigating ice and PEMF compared patients receiving ice therapy, PEMF therapy, PEMF plus ice therapy, or sham PEMF without ice therapy (control group). The results of the comparisons between the groups receiving adjuvant treatments (i.e. ice therapy, PEMF therapy, or ice and PEMF therapy) and the sham treatment were statistically significant for ice therapy in reducing pain up to 5 days. The effect of PEMF therapy and PEMF plus ice therapy on pain was not statistically significant compared to the sham control patients (Figure 44).

There were no studies investigating other mechanical adjuvant treatments (e.g. electrical bone stimulation, vibration) that met our inclusion criteria.

Figure 42 Time to healing in patients treated with ultrasound or placebo

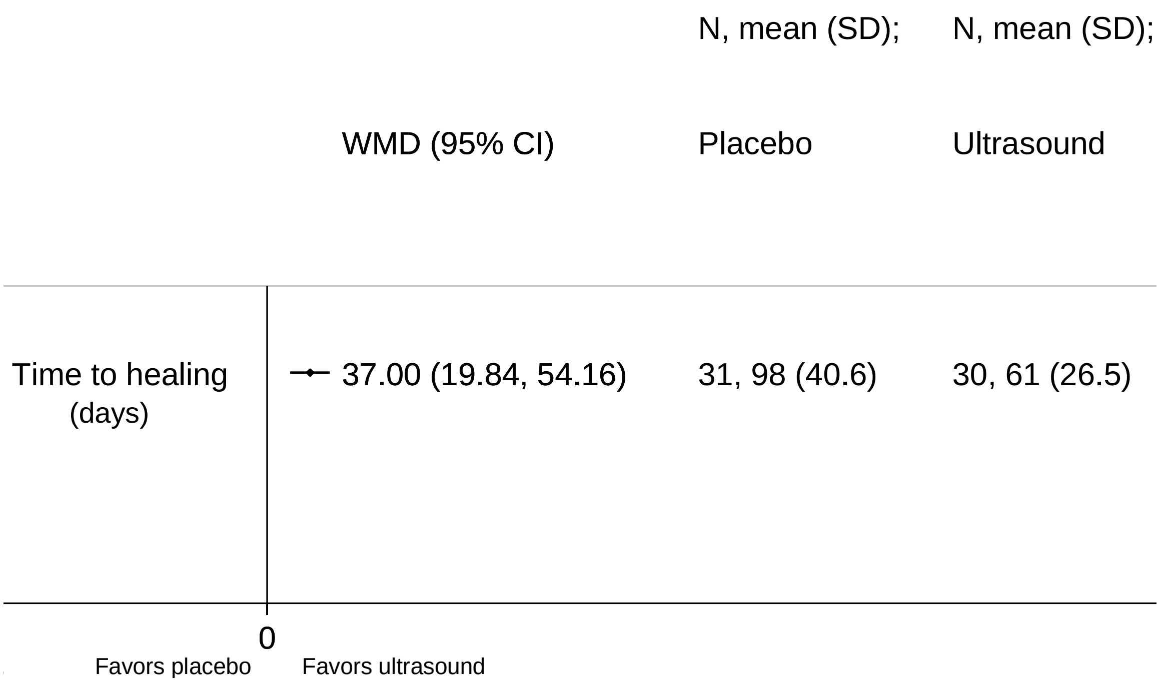


Figure 43 Number of patients with healed fractures after treatment with ultrasound or placebo

Number of fractures healed	OR (95% CI)	Ultrasound	Placebo
6 weeks	7.50 (0.84, 66.61)	6/30	1/31
8 weeks	6.75 (1.89, 24.05)	15/30	4/31
10 weeks	9.72 (2.97, 31.79)	21/30	6/31
12 weeks	18.90 (4.61, 77.46)	27/30	10/31

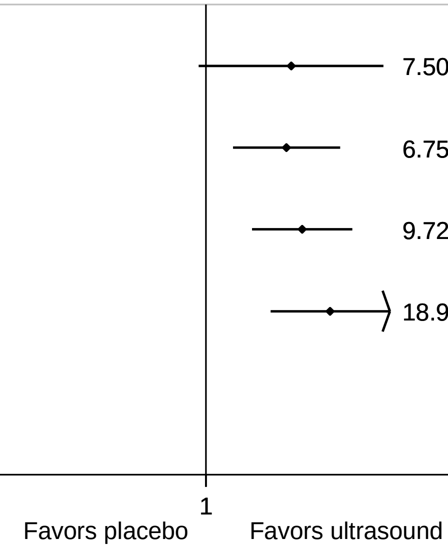
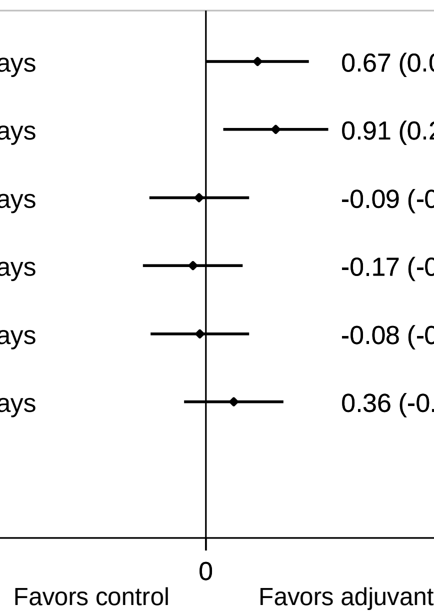


Figure 44 Pain in patients treated with adjuvant or sham treatment

Pain - VAS

Adjuvant	Duration	SMD (95% CI)	N, mean (SD); Control	N, mean (SD) Adjuvant
Ice	3 days	0.67 (0.01, 1.33)	16, 3.7 (1.2)	22, 3 (.87)
Ice	5 days	0.91 (0.23, 1.59)	16, 3.1 (1.1)	22, 2.2 (.87)
PEMF	3 days	-0.09 (-0.73, 0.56)	16, 3.7 (1.2)	22, 3.8 (1.1)
PEMF	5 days	-0.17 (-0.81, 0.48)	16, 3.1 (1.1)	22, 3.3 (1.2)
PEMF + Ice	3 days	-0.08 (-0.72, 0.56)	16, 3.7 (1.2)	23, 3.8 (1.3)
PEMF + Ice	5 days	0.36 (-0.28, 1.01)	16, 3.1 (1.1)	23, 2.6 (1.5)



RECOMMENDATION 28

We are unable to recommend for or against fixation of ulnar styloid fractures associated with distal radius fractures.

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

Ulnar styloid fractures are relatively common in association with distal radius fractures. We were interested in the effect of concomitant fixation of the styloid on patient outcome. One study found no difference between treatment (fixation) and no treatment.[92] The other study identified ulna styloid fractures after treatment was completed and the study found that there were clinically important differences between patients with and without styloid fractures.[93] Therefore no ulna styloid fractures were treated at the time of surgery. Although the patients with ulna styloid fractures had poorer outcomes, the study did not address the question of whether early operative intervention is indicated. Therefore, we found no conclusive evidence to recommend operative or non operative treatment for the ulna styloid fracture.

Table 67 Summary table for Recommendation 28

Study	n	Level of Evidence	Outcome Domain	Duration of follow-up	Favored group
Ekenstam	40	II	Pain	2 years	○
Zenke	118	II		Final follow-up	○
Zenke	118	II	Function	1 week	no ulnar fx*
Zenke	118	II		2 weeks	no ulnar fx*
Zenke	118	II		4 weeks	no ulnar fx*
Zenke	118	II		8 weeks	no ulnar fx*
Zenke	118	II		12 weeks	no ulnar fx*
Zenke	118	II		24 weeks	no ulnar fx*

* clinically important difference compared to patients with ulnar fracture
○: no significant difference

Supporting Evidence:

Evidence Tables 71 - 75 in supplemental evidence table document.

We identified one randomized controlled trial comparing patients treated operatively for a concomitant ulna fracture to patients treated conservatively for a concomitant ulnar fracture that met our inclusion criteria. There was no significant difference between the numbers of patients that were pain free, 2 years after treatment (Figure 45).

Additionally, we identified a single prospective non-randomized study which compared patients without a concomitant ulna fracture to patients with a concomitant fracture of the base or tip of the ulna that met our inclusion criteria. The patients with concomitant ulnar fractures did not receive any treatment for their ulnar fracture. Therefore, the comparison between the groups in this study determines the effect of an untreated concomitant ulnar fracture on the outcome. Patients without concomitant ulna fracture had clinically important differences in function as determined by the DASH instrument compared to those with a concomitant ulna fracture (Figure 46 and Figure 47). Additionally, there was no significant difference between patients with and without concomitant ulna fracture in the occurrence of ulnar wrist pain at final follow-up (Figure 48 and Figure 49).

Figure 45 Pain free patients 2 years after operative or non-operative treatment of concomitant ulna fracture

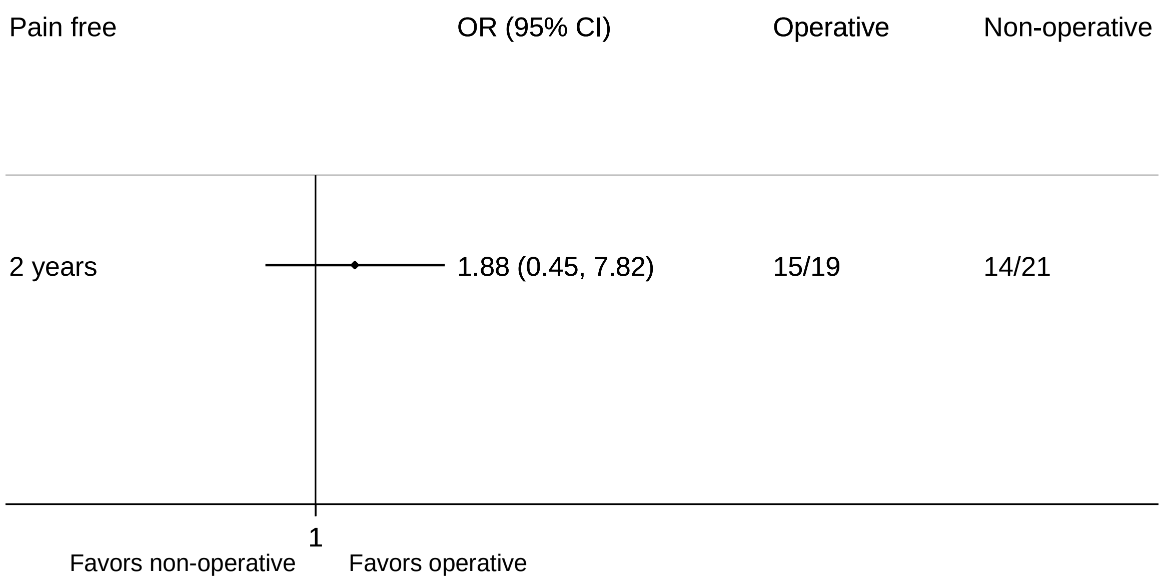


Figure 46 DASH score in patients with no ulnar fracture or ulnar base fracture

DASH	SMD (95% CI)	N, mean (SD); Ulnar base fracture	N, mean (SD); No ulnar fracture
1 week	2.50 (1.95, 3.06)	41, 58.9 (2.45)	50, 52.8 (2.37)
2 weeks	2.35 (1.80, 2.89)	41, 40.4 (2)	50, 35.7 (2)
4 weeks	3.94 (3.22, 4.65)	41, 25.8 (2.3)	50, 18.4 (1.41)
8 weeks	2.14 (1.62, 2.66)	41, 13.8 (1.41)	50, 10.8 (1.34)
12 weeks	0.31 (-0.11, 0.72)	41, 7.7 (.96)	50, 7.4 (.965)
24 weeks	1.79 (1.30, 2.29)	41, 4.14 (.74)	50, 2.96 (.57)

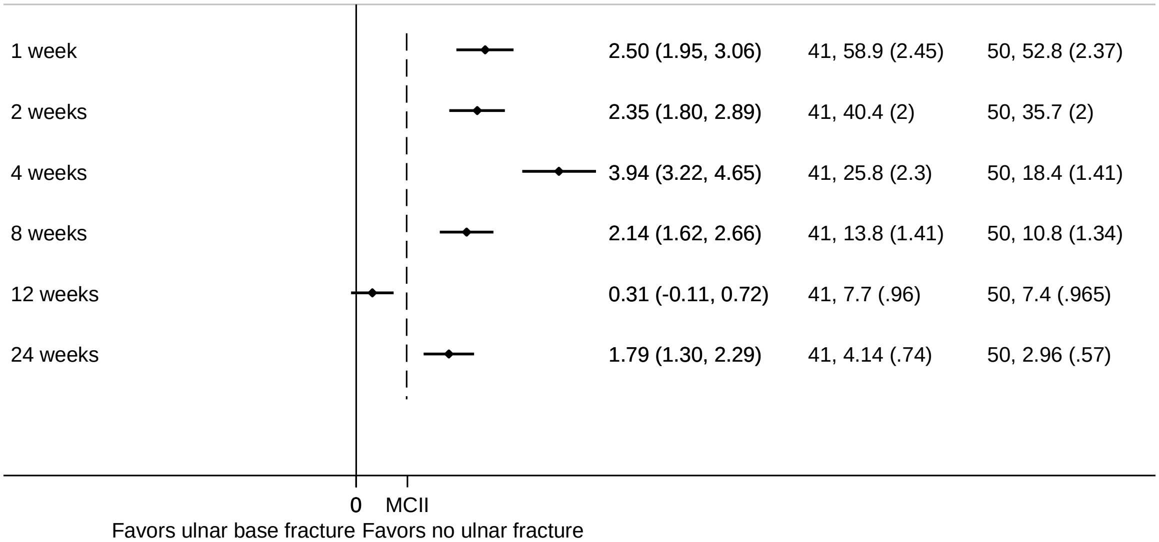


Figure 47 DASH score in patients with no ulnar fracture or ulnar tip fracture

DASH	SMD (95% CI)	N, mean (SD); Ulnar tip fracture	N, mean (SD); No ulnar fracture
1 week	2.69 (2.05, 3.33)	27, 59.3 (2.44)	50, 52.8 (2.37)
2 weeks	3.31 (2.59, 4.02)	27, 42.2 (1.85)	50, 35.7 (2)
4 weeks	5.95 (4.87, 7.02)	27, 27.8 (1.85)	50, 18.4 (1.41)
8 weeks	4.75 (3.85, 5.65)	27, 17.6 (1.56)	50, 10.8 (1.34)
12 weeks	3.45 (2.72, 4.18)	27, 10.9 (1.11)	50, 7.4 (.965)
24 weeks	2.91 (2.24, 3.57)	27, 4.74 (.67)	50, 2.96 (.57)

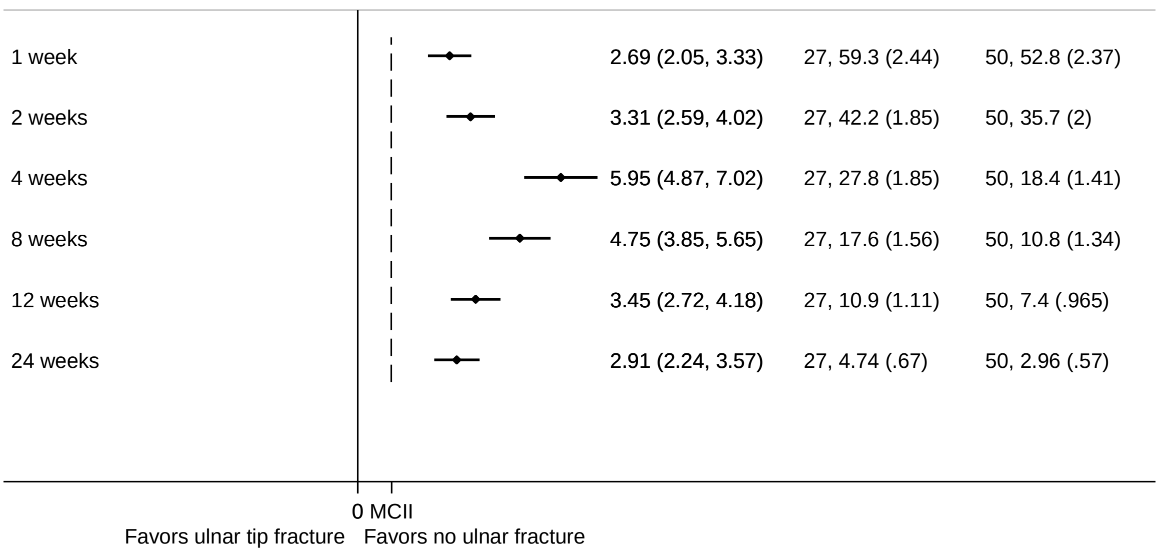


Figure 48 Wrist pain at final follow-up in patients with no ulnar fracture or ulnar base fracture

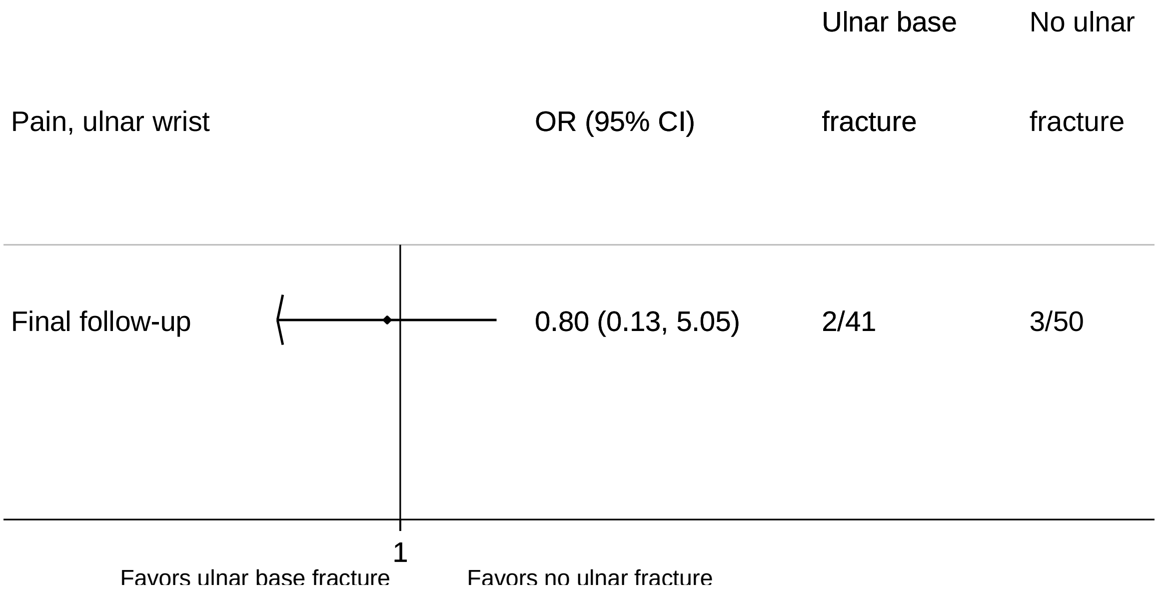
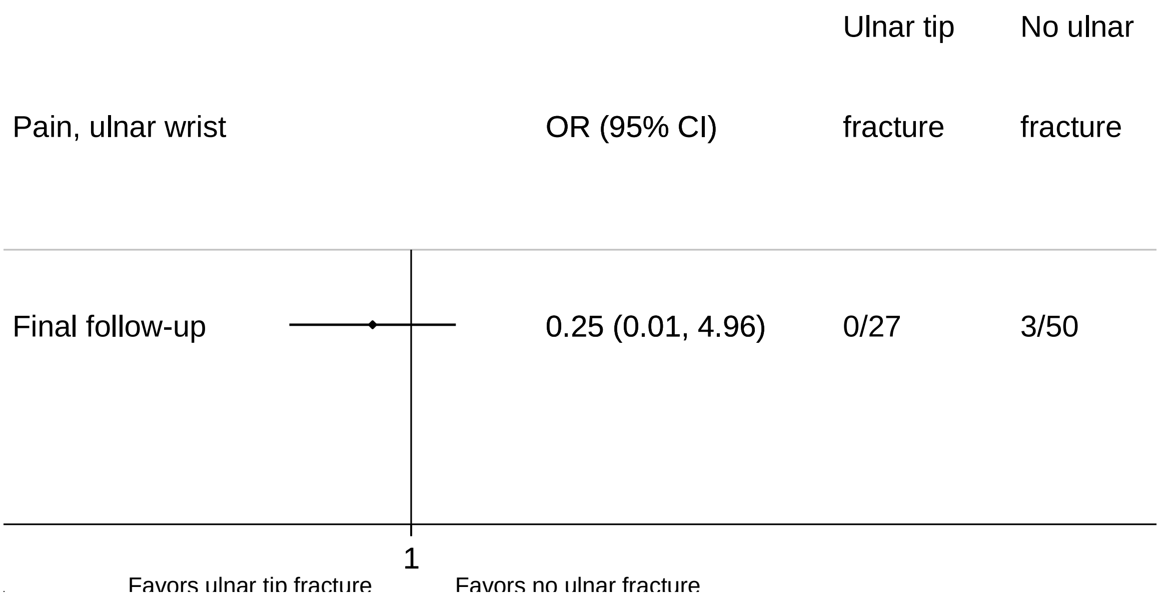


Figure 49 Wrist pain at final follow-up in patients with no ulnar fracture or ulnar tip fracture



RECOMMENDATION 29

We are unable to recommend for or against using external fixation alone for the management of distal radius fractures where there is depressed lunate fossa or 4-part fracture (sagittal split).

Strength of Recommendation: Inconclusive

Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.

Implications: Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as **Inconclusive** and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

Rationale:

There were no qualified studies identified that addressed this recommendation.

Supporting Evidence:

Evidence Table 76 in supplemental evidence table document.

There were no studies investigating concurrent methods of fixation in addition to external fixation for depressed lunate fossa or 4-part fracture of the distal radius that met our inclusion criteria.

FUTURE RESEARCH

The overall literature base for the treatment of distal radius fractures is large compared to other orthopaedic topics but still lacks highly reliable evidence. To achieve a highly reliable literature base, academic authors and scientists should invest their time and effort in studies designed to avoid bias. Techniques to limit bias include proper randomization and adequate, verified blinding of investigators, patients, and/or evaluators, wherever possible.

Future studies should also include a priori power analyses to ensure clinically important improvements (improvement that matters to the patient). These studies should utilize patient oriented outcome measures that are anatomical region-specific (DASH), disease specific (PRWE) and (if possible) general health specific (SF-36) whose key psychometric characteristics have been evaluated and validated. The use of validated patient-oriented outcome measures will ensure that the measure of success of future studies is determined by minimal clinically important improvements. Primary study questions should be based on differences on validated upper-extremity specific disability measures and secondary study questions on measures of objective impairment and radiographic measurements.

There are reasons, of course, that reliable evidence for surgical treatment is generally lacking. The logistical difficulties and ethical concerns in conducting placebo-controlled studies of operative interventions compromise the reliability of these studies. To improve the reliability of future studies of operative treatments, the use of active, non-placebo control groups should be considered. Investigators should develop rigorous patient inclusion criteria to ensure that patients that typically receive the surgical intervention in clinical practice are adequately represented in the study population.

Of the twenty-nine recommendations in this guideline, ten were supported by evidence but were still assigned an inconclusive strength of recommendation. For these recommendations, the supporting evidence found no significant or clinically important differences in the comparisons addressed or the supporting evidence was conflicting. In addition, six recommendations are supported only by limited evidence. Many of these study comparisons should be readdressed in future research to allow for meta-analytical techniques which may resolve controversy and clarify optimal treatment for distal radius fractures.

Another critical issue with reference to distal radius fractures is the bimodal incidence with high energy injuries seen largely in the younger active population and less complex injuries in the low demand generally older population. Clearly the injury severity and patient expectations (and hence outcomes) are different for both groups. Future studies should address these groups of patients individually. While previous studies have made the distinction on basis of chronologic age, this clearly is not as reliable as activity level. An initial study attempting to better define a "low-demand" individual on basis of activity level is urgently needed.

High quality trials that we would like to see addressed in the future include:

Studies to better define the minimally clinically important improvement (MCII) in an upper extremity specific disability measure for patients recovering from a fracture of the distal radius. This MCII will be the basis for power calculations for clinical trials addressing methods of treatment for fractures of the distal radius.

Prospective randomized clinical trials comparing operative treatment with non-operative treatment, separating articular and non-articular fractures, and separating older, infirm, low demand patients from younger, active patients. Consideration should be given to whether withholding operative treatment in younger, active patients in whom comparative effectiveness trials might be more appropriate, is ethical.

Prospective randomized clinical trials comparing casting to operative fixation to determine the preferable treatment for patients with displaced DRF that has been reduced manually and is currently in good alignment.

Prospective randomized controlled trials comparing operative treatment with non-operative treatment to determine the preferable treatment of elderly and sedentary patients with displaced fractures.

Prospective randomized clinical trials comparing the effectiveness of various forms of operative treatment, separating articular and non-articular fractures, and separating older, infirm, low demand patients, with lower energy injuries from younger, healthier, more active patients with higher-energy injuries. Criteria other than chronological age will also need to be addressed. Previously studied comparisons should continue to be studied to allow for future meta-analysis. Multiple treatment studies investigating 3 or more forms of operative treatment will also be useful in clarifying the optimal operative technique.

Prospective randomized clinical trials that evaluate, with validated patient outcomes, the effect of non-operative adjuvant modalities such as:

- Vitamins and minerals (e.g. vitamin C, calcium)
- Physical therapy (e.g. early formal physical therapy, self supervised home programs)
- Mechanical adjuvants (e.g. PEMF, ultrasound, electrical stimulation)

Prospective randomized clinical trials comparing surgical or expectant treatment of carpal tunnel syndrome in association with acute DRF.

Prospective randomized clinical trials that evaluate the effect of adjuvant bone grafts or substitutes with concurrent operative fixation for specific patterns of DRF.

Prospective randomized clinical trials that evaluate the effect of bone graft in association with locking plates for elderly and sedentary patients.

Prospective studies that evaluate the predictive value of low-energy DRF in relation to osteoporosis outcomes using appropriate statistical techniques and studies that investigate, with validated patient outcomes, the role of the orthopaedic surgeon in the pathway for the evaluation of potential osteoporosis in patients experiencing a low-energy DRF.

Prospective randomized clinical trials to evaluate whether immobilization of the elbow is preferable to a short arm cast in patients treated with cast immobilization.

Prospective randomized clinical trials to evaluate whether concomitant arthroscopic or open evaluation and treatment (vs. no treatment or delayed treatment) of associated wrist bone and ligament injuries, improves patient outcomes in the treatment of acute DRF.

A clinical or radiographic measure of DRUJ instability that can reliably be applied intraoperatively after radius fixation remains to be developed. In addition, prospective randomized clinical trials to evaluate whether the early identification and treatment of DRUJ instability or distal ulna fractures (e.g. styloid base or tip) improves patient outcomes are needed.

In conclusion, while distal radius fractures are well studied, reliable evidence is lacking in many key areas that may improve patient care or increase efficient use of resources and thereby reduce healthcare costs. Healthcare is evolving and patients as well as third party payers are demanding proven treatment efficacy. Evidence-based medicine can help healthcare providers provide this proof but only if the current state of medical research quality improves.

IV. APPENDIXES

APPENDIX I
WORK GROUP

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APPENDIX II
AAOS BODIES THAT APPROVED THIS CLINICAL PRACTICE GUIDELINE

Guidelines and Technology Oversight Committee
The AAOS Guidelines and Technology Oversight Committee (GTOC) consists of sixteen AAOS members. The overall purpose of this Committee is to oversee the development of the clinical practice guidelines, performance measures, health technology assessments and utilization guidelines.

Evidence Based Practice Committee
The AAOS Evidence Based Practice Committee (EBPC) consists of ten AAOS members. This Committee provides review, planning and oversight for all activities related to quality improvement in orthopaedic practice, including, but not limited to evidence-based guidelines, performance measures, and outcomes.

Council on Research, Quality Assessment, and Technology
To enhance the mission of the AAOS, the Council on Research, Quality Assessment, and Technology promotes the most ethically and scientifically sound basic, clinical, and translational research possible to ensure the future care for patients with musculoskeletal disorders. The Council also serves as the primary resource to educate its members, the public, and public policy makers regarding evidenced-based medical practice, orthopaedic devices and biologics, regulatory pathways and standards development, patient safety, occupational health, technology assessment, and other related areas of importance.

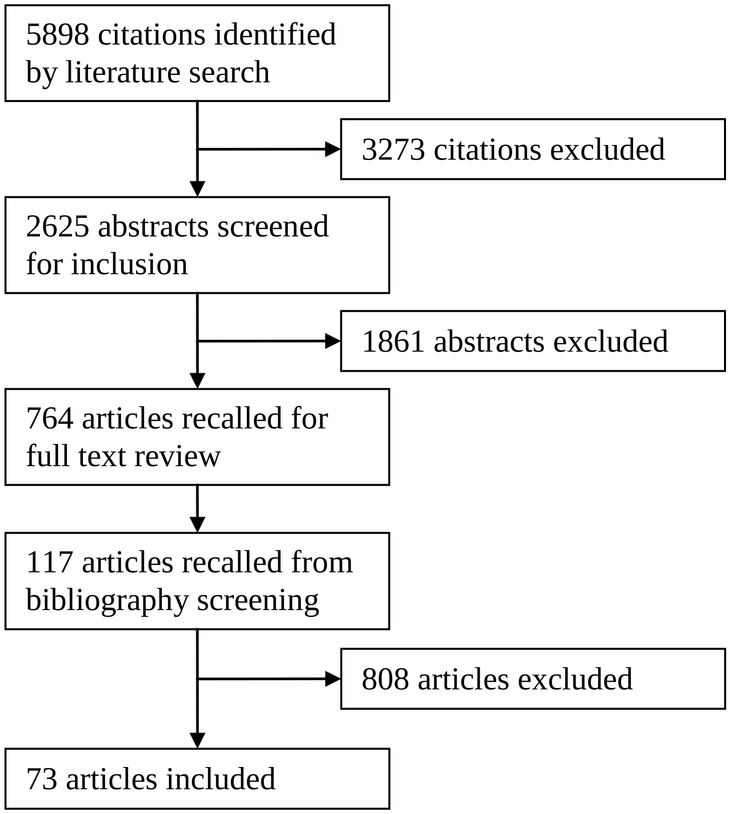
The Council is comprised of the chairs of the AAOS Biological Implants, Biomedical Engineering, Evidence Based Practice, Guidelines and Technology Oversight, Occupational Health and Workers' Compensation, Patient Safety, Research Development, and US Bone and Joint Decade committees. Also on the Council are the AAOS second vice-president, representatives of the Diversity Advisory Board, the Women's Health Issues Advisory Board, the Board of Specialty Societies (BOS), the Board of Councilors (BOC), the Communications Cabinet, the Orthopaedic Research Society (ORS), the Orthopedic Research and Education Foundation (OREF), and three members at large.

Board of Directors
The 17 member AAOS Board of Directors manages the affairs of the AAOS, sets policy, and determines and continually reassesses the Strategic Plan.

DOCUMENTATION OF APPROVAL

AAOS Work Group Draft Completed	July 31, 2009
Peer Review Completed	September 28, 2009
Public Commentary Completed	October 31, 2009
AAOS Guidelines and Technology Oversight Committee	November 17, 2009
AAOS Evidence Based Practice Committee	November 17, 2009
AAOS Council on Research Quality Assessment and Technology	November 19, 2009
AAOS Board of Directors	December 5, 2009

APPENDIX III
STUDY ATTRITION FLOWCHART



APPENDIX IV
LITERATURE SEARCHES

Search Strategy for PubMed

((Radius fractures[mh] OR Radius/injuries[mh] OR Radius/surgery[mh] OR Radius/radiography[mh] OR ((fracture*[tiab] OR “fractures, bone”[mesh:noexp]) AND (radius[tw] OR radial[tiab]))) AND (distal[tw] OR (lower[tiab] AND end[tiab]) OR wrist[tw] OR radioulnar[tw] OR radiocarpal[tw])) OR (fracture*[tiab] AND (chauffeur*[tiab] OR radiocarpal[tw] OR radioulnar[tw])) OR “smith’s fracture”[tiab] OR "colles' fracture"[tiab] OR "barton's fracture"[tiab]

AND English[lang] AND (human[mh] OR in process[sb] OR publisher[sb])

NOT (comment[pt] OR editorial[pt] OR letter[pt] OR addresses[pt] OR news[pt] OR "newspaper article"[pt] OR "case reports"[pt] OR “historical article”[pt] OR (“case series”[tw] AND retrospective*[tw]) OR cadaver[mh])

Sorted by study type:

#1 Systematic[sb]

#2 (randomized controlled trial[pt] OR controlled clinical trial[pt] OR "randomized controlled trials as topic"[mh] OR random allocation[mh] OR double-blind method[mh] OR single-blind method[mh] OR clinical trial[pt] OR "clinical trials as topic"[mh] OR "clinical trial"[tw] OR ((singl*[tw] OR doubl*[tw] OR trebl*[tw] OR tripl*[tw]) AND (mask*[tw] OR blind*[tw])) OR "latin square"[tw] OR placebos[mh] OR placebo*[tw] OR random*[tw] OR research design[mh:noexp] OR "comparative study "[pt] OR "evaluation studies as topic"[mh] OR "evaluation studies "[pt] OR "follow-Up studies"[mh] OR "prospective studies"[mh] OR "cross-over studies"[mh] OR control*[tw] OR prospectiv*[tw] OR volunteer*[tw])

NOT #1 OR #2

Search strategy for EMBASE

(‘radius fracture’/de OR ((radius OR radial OR radiocarpal OR radioulnar) AND (fracture* OR 'wrist fracture'/exp)) OR ‘smiths fracture’ OR ‘colles fracture’ OR ‘bartons fracture’ OR (chauffeur* AND fracture*)) AND ([article]/lim OR [conference paper]/lim OR [review]/lim) AND [english]/lim AND [humans]/lim AND [embase]/lim NOT [01/6/2009]/sd

Sorted by study type

#1 'meta analysis' OR 'systematic review' OR medline

#2 random* OR 'clinical trial' OR 'health care quality'/exp

NOT #1 OR #2

Search strategy for CINAHL

MM "Radius Fractures" OR ((radius OR radial OR radiocarpal OR radioulnar OR chauffeur*) AND (fracture* OR MM “Wrist Fractures”) OR "smith's fracture" OR "colles' fracture" OR "bartons fracture")

Limiters - Research Article; Language: English;

Search strategy for Cochrane Central

fracture* AND (radius OR radial)

APPENDIX V
DATA EXTRACTION ELEMENTS

The data elements below were extracted into electronic forms in Microsoft® Access. The extracted information includes:

Study Characteristics

- methods of randomization and allocation
- blinding of patients and evaluators
- loss to follow-up
- study entry group characteristics
- study design
- significant differences in surrogate measures (function and radiographic)
- significant differences in non-validated outcomes

Patient Characteristics

- patient inclusion/exclusion criteria
- age
- gender
- fracture classification
- device removal / length of fixation
- preoperative differences (demographics and outcomes)

Results (for all relevant outcomes in a study)

- outcome measure
- duration of follow up
- mean or median
- measure of dispersion
- results of hypothesis testing

APPENDIX VI
JUDGING THE QUALITY OF TREATMENT STUDIES
RANDOMIZED CONTROLLED TRIALS

Did the study employ stochastic randomization?

Was there concealment of allocation?

Were subjects blinded to the treatment they received?

Were those who assessed/rated the patient's outcomes blinded to the group to which the patients were assigned?

Was there more than 80% follow-up for all patients in the control group and the experimental group on the outcome of interest?

Did patients in the different study groups have similar levels of performance on ALL of the outcome variables at the time they were assigned to groups?

For randomized crossover studies, was there evidence that the results obtained in the study's two experimental groups (in period 1 and 2) did not differ?

For randomized crossover studies, was there evidence that the results of the two control groups (in period 1 and 2) did not differ?

PROSPECTIVE NON- RANDOMIZED CONTROLLED STUDIES

Were the characteristics of patients in the different study groups comparable at the beginning of the study?

Did patients in the different study groups have similar levels of performance on ALL of the outcome variables at baseline?

Were all of the study's groups concurrently treated?

Was there more than 80% follow-up for all patients in the control group and the experimental group on the outcome of interest?

Did the study avoid collecting control group data from one center and experimental group data from another?

For crossover studies, was there evidence that the results obtained in the study's two experimental groups (in period 1 and 2) did not differ?

For crossover studies, was there evidence that the results of the two control groups (in period 1 and 2) did not differ?

RETROSPECTIVE COMPARATIVE STUDIES

Was there less than 20% difference in completion rates in the study's groups?

Were all of the study's groups concurrently treated?

Was the same treatment given to all patients enrolled in the experimental and

Were the same laboratory tests, clinical findings, psychological instruments, etc. used to measure the outcomes in all of the study's groups?

Were the follow-up times in all of the study's relevant groups approximately equal?

Was there more than 80% follow-up for all patients in the control group and the experimental group on the outcome of interest?

Did the study avoid collecting control group data from one center and experimental group data from another?

Did patients in the different study groups have similar levels of performance on ALL of the outcome variables at the time they were assigned to groups?

Were the characteristics of patients in the different study groups comparable at the beginning of the study?

CASE SERIES

Was enrollment in the study consecutive?

Was there more than 80% follow-up for all patients on the outcome of interest?

Were the same laboratory tests, clinical findings, psychological instruments, etc. used to measure the outcomes in all patients?

Were the patients instructed/not given concomitant or adjuvant treatments?

Were the follow-up times for all patients approximately equal?

JUDGING THE QUALITY OF DIAGNOSTIC STUDIES

The QUADAS tool[14, 94, 95] is used to identify sources of bias, variability, and the quality of reporting in studies of diagnostic accuracy. Fourteen questions answered "yes", "no", or "unclear" contribute to the QUADAS tool. There is no score derived from the use of the QUADAS tool.

Was the spectrum of patient's representative of the patients who will receive the test in practice?

Were selection criteria clearly described?

Is the reference standard likely to correctly classify the target condition?

Is the time period between ref. standard and index test short enough to be reasonably sure that the target condition did not change between the two tests?

Did the whole sample or a random selection of the sample, receive verification using a reference standard of diagnosis?

Did patients receive the same reference standard regardless of the index test result?

Was the reference standard independent of the index test (i.e. the index test did not form part of the reference standard)?

Was the execution of the index test described in sufficient detail to permit replication of the test?

Was the execution of the reference standard described in sufficient detail to permit its replication?

Were the index test results interpreted without knowledge of the results of the reference standard?

Were the reference standard results interpreted without knowledge of the results of the index test?

Were the same clinical data available when test results were interpreted as would be available when the test is used in practice?

Were uninterpretable/intermediate test results reported?

Were withdrawals from the study explained?

JUDGING THE QUALITY OF PROGNOSTIC STUDIES

Were the variables of interest clearly identified in the Methods section?

Were all variables of interest discussed in the Results section?

Were there sufficient patients per variable?

Were there sufficient events per variable?

If coding of variables is used, is the coding scheme described or unambiguous?

Collinearity has been tested or there is no obvious potential for collinearity?

Was the fitting procedure explicitly stated?

Were any goodness-of-fit statistics reported?

Was the model subjected to a test of validation?

APPENDIX VII
FORM FOR ASSIGNING STRENGTH OF RECOMMENDATION (INTERVENTIONS)

GUIDELINE RECOMMENDATION___________________________________

PRELIMINARY STRENGTH OF RECOMMENDATION: ________________

STEP 1: LIST BENEFITS AND HARMS

Please list the benefits (as demonstrated by the systematic review) of the intervention.

Please list the harms (as demonstrated by the systematic review) of the intervention.

Please list the benefits for which the systematic review is not definitive.

Please list the harms for which the systematic review is not definitive.

STEP 2: IDENTIFY CRITICAL OUTCOMES

Please circle the above outcomes that are critical for determining whether the intervention is beneficial and whether it is harmful.

Are data about critical outcomes lacking to such a degree that you would lower the preliminary strength of the recommendation?

What is the resulting strength of recommendation?

STEP 3: EVALUATE APPLICABILITY OF THE EVIDENCE

Is the applicability of the evidence for any of the critical outcomes so low that substantially worse results are likely to be obtained in actual clinical practice?

Please list the critical outcomes backed by evidence of doubtful applicability.

Should the strength of recommendation be lowered because of low applicability?

What is the resulting strength of recommendation?

STEP 4: BALANCE BENEFITS AND HARMS

Are there trade-offs between benefits and harms that alter the strength of recommendation obtained in STEP 3?

What is the resulting strength of recommendation?

STEP 5 CONSIDER STRENGTH OF EVIDENCE

Does the strength of the existing evidence alter the strength of recommendation obtained in STEP 4?

What is the resulting strength of recommendation?

NOTE: Because we are not performing a formal cost analyses, you should only consider costs if their impact is substantial.

APPENDIX VIII

VOTING BY THE NOMINAL GROUP TECHNIQUE

Voting on guideline recommendations will be conducted using a modification of the nominal group technique (NGT), a method previously used in guideline development.[15] Briefly each member of the guideline work group ranks his or her agreement with a guideline recommendation on a scale ranging from 1 to 9 (where 1 is "extremely inappropriate" and 9 is "extremely appropriate"). Consensus is obtained if the number of individuals who do not rate a measure as 7, 8, or 9 is statistically non-significant (as determined using the binomial distribution). Because the number of work group members who are allowed to dissent with the recommendation depends on statistical significance, the number of permissible dissenters varies with the size of the work group. The number of permissible dissenters for several work group sizes is given in the table below:

Work group Size	Number of Permissible Dissenters
≤ 3	Not allowed, statistical significance cannot be obtained
4-5	0
6-8	1
9	1 or 2

The NGT is conducted by first having members vote on a given recommendation without discussion. If the number of dissenters is "permissible", the recommendation is adopted without further discussion. If the number of dissenters is not permissible, there is further discussion to see whether the disagreement(s) can be resolved. Three rounds of voting are held to attempt to resolve disagreements. If disagreements are not resolved after three voting rounds, no recommendation is adopted.

OPINION-BASED RECOMMENDATIONS

A guideline can contain recommendations that are backed by little or no data. Under such circumstances, work groups often issue opinion-based recommendations. Although doing so is sometimes acceptable in an evidence-based guideline (expert opinion is a form of evidence), it is also important to avoid constructing a guideline that liberally uses expert opinion; research shows that expert opinion is often incorrect.

Opinion-based recommendations are developed only if they address a vitally important aspect of patient care. For example, constructing an opinion-based recommendation in favor of taking a history and physical is warranted. Constructing an opinion-based recommendation in favor of a specific modification of a surgical technique is seldom warranted. To ensure that an opinion-based recommendation is absolutely necessary, the

AAOS has adopted rules to guide the content of the rationales that underpin such recommendations. These rules are based on those outlined by the US Preventive Services Task Force (USPSTF).[96] Specifically, rationales based on expert opinion must:

- Not contain references to or citations from articles not included in the systematic review that underpins the recommendation.

- Not contain the AAOS guideline language “We Recommend”, “We suggest” or “treatment x is an option”.

- Contain an explanation of the potential preventable burden of disease. This involves considering both the incidence and/or prevalence of the disease, disorder, or condition and considering the associated burden of suffering. To paraphrase the USPSTF, when evidence is insufficient, provision of a treatment (or diagnostic) for a serious condition might be viewed more favorably than provision of a treatment (or diagnostic) for a condition that does not cause as much suffering. The AAOS (like the USPSTF) understand that evaluating the “burden of suffering” is subjective and involves judgment. This evaluation should be informed by patient values and concerns. The considerations outlined in this bullet make it difficult to recommend new technologies. It is not appropriate for a guideline to recommend widespread use of a technology backed by little data and for which there is limited experience. Such technologies are addressed in the AAOS’ Technology Overviews.

- Address potential harms. In general, “When the evidence is insufficient, an intervention with a large potential for harm (such as major surgery) might be viewed less favorably than an intervention with a small potential for harm (such as advice to watch less television).”[96]

- Address apparent discrepancies in the logic of different recommendations. Accordingly, if there are no relevant data for several recommendations and the work group chooses to issue an opinion-based recommendation in some cases but chooses not to make a recommendation in other cases, the rationales for the opinion-based recommendations must explain why this difference exists. Information garnered from the previous bullet points will be helpful in this regard.

- Consider current practice. The USPSTF specifically states that clinicians justifiably fear that not doing something that is done on a widespread basis will lead to litigation. The consequences of not providing a service that is neither widely available nor widely used are less serious than the consequences of not providing a treatment accepted by the medical profession and thus expected by patients.[96] Discussions of available treatments and procedures rely on mutual communication between the patient’s guardian and physician, and on weighing the potential risks and benefits for a given patient. The patient’s “expectation of treatment” must be tempered by the treating physician's guidance about the reasonable outcomes that the patient can expect.

- Justify, why a more costly device, drug, or procedure is being recommended over a less costly one whenever such an opinion-based recommendation is made.

Work group members write the rationales for opinion based recommendations on the first day of the final work group meeting. When the work group re-convenes on the second day of its meeting, it will vote on the rationales. The typical voting rules will apply. If the work group cannot adopt a rationale after three votes, the rationale and the opinion-based recommendation will be withdrawn, and a "recommendation" stating that the group can neither recommend for or against the recommendation in question will appear in the guideline.

Discussions of opinion-based rationales may cause some members to change their minds about whether to issue an opinion-based recommendation. Accordingly, at any time during the discussion of the rationale for an opinion-based recommendation, any member of the work group can make a motion to withdraw that recommendation and have the guideline state that the work group can neither recommend for or against the recommendation in question.

CHECKLIST FOR VOTING ON OPINION-BASED RECOMMENDATIONS

When voting on the rationale, please consider the following:

1. Does the recommendation affect a substantial number of patients or address treatment (or diagnosis) of a condition that causes death and/or considerable suffering?

2. Does the recommendation address the potential harms that will be incurred if it is implemented and, if these harms are serious, does the recommendation justify;

    a. why the potential benefits outweigh the potential harms and/or

    b. why an alternative course of treatment (or diagnostic workup) that involves less serious or fewer harms is not being recommended?

3. Does the rationale explain why the work group chose to make a recommendation in the face of minimal evidence while, in other instances, it chose to make no recommendation in the face of a similar amount of evidence?

4. Does the rationale explain that the recommendation is consistent with current practice?

5. If relevant, does the rationale justify why a more costly device, drug, or procedure is being recommended over a less costly one?

APPENDIX IX

STRUCTURED PEER REVIEW FORM

Review of any AAOS confidential draft allows us to improve the overall guideline but does not imply endorsement by any given individual or any specialty society who participates in our review processes. The AAOS review process may result in changes to the documents; therefore, endorsement cannot be solicited until the AAOS Board of Directors officially approves the final guideline.

Reviewer Information:

Name of Reviewer____
Address____
City__________________ State________________ Zip Code__________
Phone ____________________Fax _______________________
E-mail______________________

Specialty Area/Discipline: ____________________________________
Work setting: ____
Credentials: ____

May we list you as a Peer Reviewer in the final Guidelines? ☐ Yes ☐ No

Are you reviewing this guideline as a representative of a professional society? ☐ Yes ☐ No

If yes, may we list your society as a reviewer of this guideline? ☐ Yes ☐ No

Reviewer Instructions

Please read and review this Draft Clinical Practice Guideline and its associated Evidence Report with particular focus on your area of expertise. Your responses are confidential and will be used only to assess the validity, clarity, and accuracy of the interpretation of the evidence. If applicable, please specify the draft page and line numbers in your comments. Please feel free to also comment on the overall structure and content of the guideline and Evidence Report.

If you need more space than is provided, please attach additional pages.
Please complete and return this form electronically to wies@aaos.org or fax the form back to Jan Wies at (847) 823-9769.

Thank you in advance for your time in completing this form and giving us your feedback. We value your input and greatly appreciate your efforts. Please send the completed form and comments by *Month/Day/Year*.

	Please indicate your level of agreement with each of the following Statements, by placing an "X" in the appropriate box.			
	Very much agree	**Moderately agree**	**Moderately disagree**	**Very much disagree**
1. The recommendations are clearly stated	☐	☐	☐	☐
2. There is an explicit link between the recommendations and the supporting evidence	☐	☐	☐	☐
3. Given the nature of the topic and the data, all clinically important outcomes are considered	☐	☐	☐	☐
4. The guideline's target audience is clearly described	☐	☐	☐	☐
5. The patients to whom this guideline is meant to apply are specifically described	☐	☐	☐	☐
6. The criteria used to select articles for inclusion are appropriate	☐	☐	☐	☐
7. The reasons why some studies were excluded are clearly described	☐	☐	☐	☐
8. All important studies that met the article inclusion criteria are included	☐	☐	☐	☐
9. The validity of the studies is appropriately appraised	☐	☐	☐	☐
10. The methods are described in such a way as to be reproducible.	☐	☐	☐	☐
11. The statistical methods are appropriate to the material and the objectives of this guideline	☐	☐	☐	☐
12. Important parameters (e.g., setting, study population, study design) that could affect study results are systematically addressed	☐	☐	☐	☐
13. Health benefits, side effects, and risks are adequately addressed	☐	☐	☐	☐
14. The writing style is appropriate for health care professionals and patients	☐	☐	☐	☐
15. The grades assigned to each recommendation are appropriate	☐	☐	☐	☐

COMMENTS
Please provide a brief explanation of both your positive and negative answers in the preceding section. If applicable, please specify the draft page and line numbers in your comments. Please feel free to also comment on the overall structure and content of the guideline and evidence report

OVERALL ASSESSMENT

Would you recommend these guidelines for use in practice? (check one)

Strongly recommend _______

Recommend (with provisions or alterations) _______

Would not recommend _______

Unsure _______

COMMENTS:
Please provide the reason(s) for your recommendation.

APPENDIX X
PEER REVIEW PANEL

Participation in the AAOS peer review process does not constitute an endorsement of this guideline by the participating organization or the individuals listed below nor does it is any way imply the reviewer supports this document.

Peer review of the draft guideline is completed by an outside Peer Review Panel. Outside peer reviewers are solicited for each AAOS guideline and consist of experts in the guideline's topic area. These experts represent professional societies other than AAOS and are nominated by the guideline work group prior to beginning work on the guideline. For this guideline, 20 outside peer review organizations were invited to review the draft guideline and all supporting documentation. 6 societies participated in the review of the Treatment of Distal Radius Fractures guideline draft and 6 explicitly consented to be listed as a peer review organization in this appendix.

The organizations that reviewed the document and consented to be listed as a peer review organization are listed below:

American Academy of Family Physicians
American Academy of Physical Medicine and Rehabilitation
American Association for Hand Surgery
American College of Occupational and Environmental Medicine
American Society for Surgery of the Hand
American Society of Plastic Surgeons

Individuals who participated in the peer review of this document and gave their consent to be listed as reviewers of this document are:

Blair C. Filler, MD
M. Felix Freshwater, MD
Steven Z. Glickel, MD
Michael H. Heggeness, MD, PhD
Harvey Insler, MD
Loree K. Kalliainen, MD, FACS
Douglas W. Lundy, MD
Ariz R. Mehta, MD
J. Mark Melhorn, MD
Charles A. Reitman, MD
Bruce Rougraff, MD
Thomas Trumble, MD

One individual that provided peer review declined consent to be listed as a reviewer in this document.

Participation in the AAOS guideline peer review process does not constitute an endorsement of the guideline by the participating organizations or the individuals listed above nor does it is any way imply the reviewer supports this document.

PUBLIC COMMENTARY

A period of public commentary follows the peer review of the draft guideline. If significant non-editorial changes are made to the document as a result of public commentary, these changes are also documented and forwarded to the AAOS bodies that approve the final guideline.

Public commentators who gave explicit consent to be listed in this document include the following:

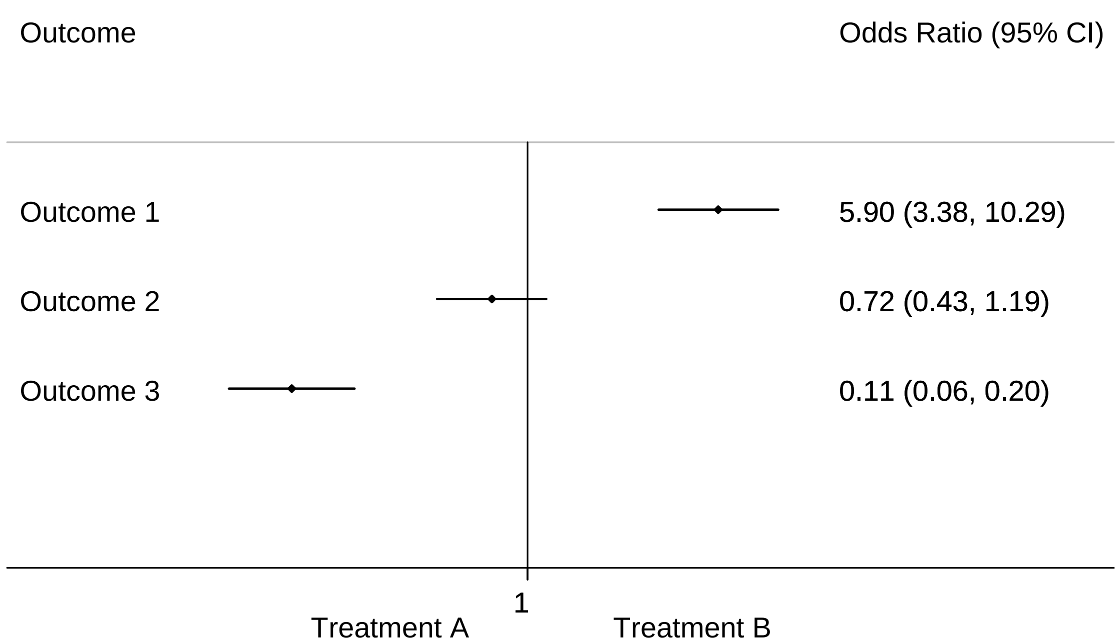
Joseph Borrelli, Jr MD
Ruby Grewal, MD
Kurt F. Konkel, MD
J. Tracy Watson, MD

Participation in the AAOS guideline public commentary review process does not constitute an endorsement of the guideline by the participating organizations or the individual listed nor does it in any way imply the reviewer supports this document.

APPENDIX XI
INTERPRETING THE FOREST PLOTS

Throughout the guideline we use descriptive diagrams or forest plots to present data from studies comparing the differences in outcomes between two treatment groups. In this guideline there are no meta-analyses of treatments (combining results of multiple studies into a single estimate of overall effect), so each point and corresponding horizontal line on a sample plot should be viewed independently. In the example below, the odds ratio is the effect measure used to depict differences in outcomes between the two treatment groups of a study. In other forest plots, the point can refer to other summary measures (such as the mean difference or relative risk). The horizontal line running through each point represents the 95% confidence interval for that point. In this graph, the solid vertical line represents "no effect" where the Odds Ratio, OR, is equal to one. When mean differences are portrayed, the vertical line of no effect is at zero.

For example, in the figure below the odds of a patient experiencing Outcome 1 are 5.9 times greater for patients who received Treatment B than for patients who received Treatment A.. This result is statistically significant because the 95% Confidence Interval does not cross the "no effect" line. In general, the plots are arranged such that results to the left of the "no effect" line favor Treatment A while results to the right favor Treatment B. In the example below, the odds ratio for Outcome 1 favors Treatment B, the odds ratio for Outcome 3 favors Treatment A, and the odds ratio for Outcome 2 does not favor either treatment because the 95% CI crosses the "no effect" line (i.e. the difference is not statistically significant).



ABBREVIATIONS USED IN THIS REPORT

95% CI	95% confidence interval
AAOS	American Academy of Orthopaedic Surgeons
ANOVA	analysis of variance
BOC	AAOS Board of Councilors
BOD	AAOS Board of Directors
BOS	AAOS Board of Specialty Societies
CI	confidence interval
CME	Continuing Medical Education
CORQAT	AAOS Council on Research, Quality Assessment, and Technology
CRPS	complex regional pain syndrome
CT	computerized tomography
CTS	carpal tunnel syndrome
DASH	Disabilities of the Arm Shoulder and Hand
DRF	distal radius fracture
DRUJ	distal radioulnar joint
EBP	evidence based medicine
EBPC	AAOS Evidence Based Practice Committee
Ex-fix	external fixation
fx	fracture
GRADE	Grading of Recommendations, Assessment, Development, and Evaluation
GTOC	AAOS Guidelines and Technology Oversight Committee
HSROC	hierarchical summary receiver operating characteristic curve
LT	lunotriquetral
MCID	minimal clinically important difference
MCII	minimal clinically important improvement
MFA	Musculoskeletal Functional Assessment
mm	millimeter
MRI	magnetic resonance imaging
n/a	not applicable
NGT	Nominal Group Technique
NYOH	New York Orthopaedic Hospital
OR	odds ratio
OREF	Orthopedic Research and Education Foundation
ORIF	open reduction internal fixation
ORS	Orthopaedic Research Society
PEMF	pulsed electromagnetic field
PRWE	Patient-Rated Wrist Evaluation instrument
QUADAS	Quality Assessment of Diagnostic Accuracy Studies instrument
ROC	receiver operating characteristic curve
RSD	reflex sympathetic dystrophy
SD	standard deviation

SF-12	12-Item Short Form Health Survey Instrument
SF-12	12-Item Short Form Health Survey Instrument Mental Component Score
SF-12 PCS	12-Item Short Form Health Survey Instrument Physical Component Score
SF-36	36-Item Short Form Survey Instrument
SF-36	36-Item Short Form Survey Instrument Mental Component Score
SF-36 PCS	36-Item Short Form Survey Instrument Physical Component Score
SLIL	scapholunate interosseous ligament
SMD	standardized mean difference
TFCC	triangular fibrocartilage complex
VAS	visual analog scale
VLP	volar locking plate
WMD	weighted mean difference

APPENDIX XII
CONFLICT OF INTEREST

All members of the AAOS work group disclosed any conflicts of interest prior to the development of the recommendations for this guideline. Conflicts of interest are disclosed in writing with the American Academy of Orthopaedic Surgeons via a private on-line reporting database and also verbally at the recommendation approval meeting.

Disclosure Items: (n) = Respondent answered 'No' to all items indicating no conflicts. 1=Board member/owner/officer/committee appointments; 2= Medical/Orthopaedic Publications; 3= Royalties; 4= Speakers bureau/paid presentations;5A= Paid consultant; 5B= Unpaid consultant; 6= Research or institutional support from a publisher; 7= Research or institutional support from a company or supplier; 8= Stock or Stock Options; 9= Other financial/material support from a publisher; 10= Other financial/material support from a company or supplier.

David M Lichtman, MD: 1 (Society of Medical Consultants to the Armed Forced). Submitted on: 10/20/2008 at 11:22 AM.

Randipsingh R Bindra, MD: 3 (Tornier); 4 (Small Bone Innovations; Integra NeuroSciences); 5A (Tornier; Integra NeuroSciences Inc). Submitted on: 04/26/2009 at 04:52 PM.

Martin I Boyer, MD: 2 (Journal of Bone and Joint Surgery – American; Journal of Hand Surgery – American); 5A (MiMedX; OrthoHelix, LLC; OrthoHelix, LLC; MiMedX, LLC); 5B (Pfizer; Synthes); 8 (MiMedX, LLC; OrthoHelix, LLC); 10 (Synthes). Submitted on: 06/30/2008 at 11:58 AM.

Michael J Goldberg, MD: 2 (Journal of Pediatric Orthopedics; Journal of Childrens Orthopaedics (Europe)). Submitted on: 03/18/2009 at 01:28 PM and last confirmed as accurate on 10/19/2009.

Michael Warren Keith, MD: (n). Submitted on: 10/19/2009 at 07:12 PM.

Matthew D Putnam, MD: 3 (SBI); 4 (Wright Medical Technology, Inc.); 5A (Wright Medical Technology, Inc.); 6 (Saunders/Mosby-Elsevier); 7 (Biomet; Medtronic Sofamor Danek; Synthes; Zimmer); 8 (Amgen Co; Biomet; Merck; Stryker; Wright Medical Technology, Inc.; BoundaryMedical; Med-Connections). Submitted on: 06/17/2009.

David C Ring, MD: 2 (Journal of Hand Surgery - American; Journal of Orthopaedics and Traumatology; Journal of Shoulder and Elbow Surgery; Shoulder and Elbow; Journal of Surgical Orthopaedic Advances); 3 (DePuy, A Johnson & Johnson Company; Wright Medical Technology, Inc.); 4 (Acumed, LLC; DePuy, A Johnson & Johnson Company; Synthes); 5A (Acumed, LLC; Wright Medical Technology, Inc.); 7 (Acumed, LLC; Biomet; Stryker; Tornier; Joint Active Systems); 8 (Mimedex; Illuminoss); 9 (Journal of Hand Surgery - American). Submitted on: 06/17/2009.

David Joseph Slutsky, MD: 9 (Elsevier - book royalties). Submitted on: 10/20/2009

John S Taras, MD: 1 (Owner, Union Surgical, LLC); 4 (Integra Life Sciences); 7 (Axogen). Submitted on: 10/27/2008 at 11:42 AM and last confirmed as accurate on 06/22/2009.

William Charles Watters III, MD: 1 (North American Spine Society; American Board of Spine Surgery; Board of Advisoer Official Disability Guidelines; Associate Member of The Editorial Board, The Spine Journal; Med Center Ambulatory Surgery Center); 2 (The Spine Journal); 4 (Stryker; Synthes); 5A (Orthofix, Inc.; Stryker); 8 (Intrisic Therapeutics). Submitted on: 08/14/2009

APPENDIX XIII
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