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



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# ATR Summary of Recommendations

The following is a summary of the recommendations in the AAOS' clinical practice guideline, The Diagnosis and Treatment of Acute Achilles Tendon Rupture. The scope of this guideline is specifically limited to acute Achilles tendon rupture. 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 also 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.

1. In the absence of the reliable evidence, it is the opinion of this work group that a detailed history and physical exam be performed. The physical examination should include two or more of the following tests to establish the diagnosis of acute Achilles tendon rupture:

    - Clinical Thompson test (Simmonds squeeze test)
    - Decreased ankle plantar flexion strength
    - Presence of a palpable gap (defect, loss of contour)
    - Increased passive ankle dorsiflexion with gentle manipulation

    Strength of Recommendation – **Consensus***

2. We are unable to recommend for or against the routine use of magnetic resonance imaging (MRI), ultrasound (ultrasonography), and radiograph (roentgengrams, x-rays) to confirm the diagnosis of acute Achilles tendon rupture.

    Strength of Recommendation – **Inconclusive**

3. Non-operative treatment is an option for all patients with acute Achilles tendon rupture.

    Strength of Recommendation: **Weak**

4. For patients treated non-operatively, we are unable to recommend for or against the use of immediate functional bracing for patients with acute Achilles tendon rupture

    Strength of Recommendation**: Inconclusive**

5. Operative treatment is an option in patients with acute Achilles tendon rupture.

   Strength of Recommendation: **Weak**

6. In the absence of reliable evidence, it is the opinion of the work group that although operative treatment is an option, it should be approached more cautiously in patients with diabetes, neuropathy, immunocompromised states, age above 65, tobacco use, sedentary lifestyle, obesity (BMI >30), peripheral vascular disease or local/systemic dermatologic disorders.

   Strength of Recommendation: **Consensus**

7. For patients who will be treated operatively for an acute Achilles tendon rupture, we are unable to recommend for or against preoperative immobilization or restricted weight bearing.

   Strength of Recommendation: **Inconclusive**

8. Open, limited open and percutaneous techniques are options for treating patients with acute Achilles tendon rupture.

   Strength of Recommendation: **Weak**

9. We cannot recommend for or against the use of allograft, autograft, xenograft, synthetic tissue, or biologic adjuncts in all acute Achilles tendon ruptures that are treated operatively.

   Strength of Recommendation: **Inconclusive**

10. We cannot recommend for or against the use of antithrombotic treatment for patients with acute Achilles tendon ruptures.

    Strength of Recommendation: **Inconclusive**

11. We suggest early (≤ 2 weeks) post-operative protected weight bearing for patients with acute Achilles tendon rupture who have been treated operatively

    Strength of Recommendation: **Moderate**

12. We suggest the use of a protective device that allows mobilization by 2- 4 weeks post operatively.

    Strength of Recommendation: **Moderate**

13. 13 We are unable to recommend for or against post-operative physiotherapy for patients with acute Achilles tendon rupture

Strength of Recommendation: **Inconclusive**

14. In all patients with acute Achilles tendon rupture, irrespective of treatment type, we are unable to recommend a specific time at which patients can return to activities of daily living.

    Strength of Recommendation: **Inconclusive**

15. In patients who participate in sports it is an option to return them to sports within 3-6 months after operative treatment for acute Achilles tendon rupture.

    Strength of Recommendation: **Weak**

16. In patients with acute Achilles tendon rupture treated non-operatively, we are unable to recommend a specific time at which patients can return to athletic activity.

    Strength of Recommendation: **Inconclusive**

**** While we strongly encourage reviewers to read the full guideline, please refer to the sections titled "Judging the Quality of Evidence" and "Defining the Strength of the Recommendations Table 1" for a detailed description of the link between the evidence supporting the Strength of a Recommendation and the language of the guideline.***

# Work Group

**Christopher P Chiodo MD, Chair**
Brigham Orthopedic Associates
75 Francis Street
Boston MA 02115

**Mark Glazebrook MD, Vice-Chair**
Queen Elizabeth Health Sciences Center
Halifax Infirmary Suite 4867
1796 Summer Street
Halifax NS B3H 3A7 Canada

**Eric Michael Bluman MD PhD**
Madigan Army Medical Center
ATTN: MCHJ-SOP (Ortho Clinic)
9040 A Reid Street
Tacoma WA 98431-1100

**Bruce E Cohen MD**
1783 Sterling Road
Charlotte NC 28209

**John E Femino MD**
Department of Orthopedics
University of Iowa Hospital and Clinics
JPP 01022
200 Hawkins Drive
Iowa City IA 52242

**Eric Giza MD**
UC Davis Dept of Orthopaedics
Ambulatory Care Services Bldg
4860 Y St #3800
Sacramento, CA 95817

**Guidelines and Technology Oversight Chair:**
**William C. Watters, III, MD**
6624 Fannin #2600
Houston, TX 77030

**Guidelines and Technology Oversight Vice-Chair:**
**Michael J. Goldberg, MD**
Department of Orthopaedics
Seattle Children's Hospital
4800 Sand Point Way NE
Seattle, WA 98105

**Evidence Based Practice Committee Chair:**
**Michael Keith, MD**
2500 Metro Health Drive
Cleveland, OH 44109-1900

**AAOS Staff:**
**Robert H. Haralson III, MD, MBA**
AAOS Medical Director
6300 N River Road
Rosemont, IL 60018

**Charles M. Turkelson, PhD**
Director of Research and Scientific Affairs

**Janet L. Wies MPH**
AAOS Clinical Practice Guideline Mgr

**AAOS Research Analysts**
Laura Raymond MA - Lead Analyst
Sara Anderson MPH – Lead Analyst
Kevin Boyer BS
Patrick Sluka MPH

# Peer Review

**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.**

The following organizations participated in peer review of this clinical practice guideline and gave explicit consent to be listed as a peer review organization of this document:

American Academy of Family Practitioners
American Academy of Physical Medicine and Rehabilitation
American College of Foot and Ankle Surgeons
American Orthopaedic Foot and Ankle Society
American Orthopaedic Society for Sports Medicine
American Physical Therapy Association
American Podiatric Medical Association
American Orthopaedic Foot & Ankle Society

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

Avrill Roy Berkman, MD
Christopher R. Carcia, MD
Michael Heggeness, MD
Harvey Insler, MD
John Kirkpatrick, MD
Michael S. Lee, DPM, FACFA
Angus McBryde Jr., MD
Ariz R. Mehta, MD
Lawrence Oloff, DPM
Steven Raikin, MD
Charles Reitman, MD
John Richmond, MD
Kevin Shea, MD
Naomi Sheilds, MD
Nelson F. Soohoo, MD
Glenn Weinraub, DPM, FACFAS

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# I. INTRODUCTION

## OVERVIEW

This clinical practice guideline is based on a systematic review of published studies on the treatment of acute Achilles tendon rupture in adults. Adults were defined as older than 19 years of age for this guideline. Acute Achilles tendon ruptures were defined for the literature search as those treated within the first six weeks of injury to capture all applicable literature; the patient population of the majority of studies included in this guideline are patients treated within the first two weeks of injury (See Appendix II). 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 diagnosing and treating Achilles tendon ruptures. It is also intended to serve as an information resource for decision makers 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 practice (EBP) 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 Achilles tendon ruptures. The systematic review detailed herein was conducted between December 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 Achilles tendon ruptures. 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 should not 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 must be made in light 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 Achilles tendon rupture. 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. Diagnosis and treatment for patients with acute Achilles tendon rupture are based on the assumption that decisions are predicated on

patient and physician mutual communication including 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 diagnosis and treatment of acute Achilles tendon rupture in adults (defined as patients 19 years of age and older).

## INCIDENCE

The incidence of Achilles tendon ruptures has been estimated to range from an annual average of 5.5 ruptures to 9.9 ruptures per 100,000 people in North America (Edmonton, Canada).[1] Studies of European communities report comparable values ranging from 6 to 18 ruptures per 100,000 people.[1-4]

## BURDEN OF DISEASE

Those afflicted with an acute Achilles tendon rupture face a healing period that requires time away from work and limited athletic activity. Time away from work may impact the patient financially and limiting activity may impact the patient's health.[5]

## ETIOLOGY

Most acute Achilles tendon ruptures are traumatic in origin. Some studies have shown that ruptured Achilles tendons have occult degeneration.[3]

## RISK FACTORS

Most ruptures of the Achilles tendons occur during sports activities, are more common in males in the third or fourth decade of life, and occur more frequently on the left side.[1]

## EMOTIONAL AND PHYSICAL IMPACT OF ACHILLES TENDON RUPTURE

Acute Achilles tendon rupture often results in sudden pain in the affected leg, the inability to bear weight and noticeable weakness of the affected ankle.[3] The injury often results in the patient's inability to walk or perform their regular activities of daily living. Patients face possible deformity if the tendon does not heal correctly and a substantial recovery period. Possible complications associated with Achilles tendon rupture include rerupture and, in cases of surgical repair, infection.

## POTENTIAL BENEFITS, HARMS, AND CONTRAINDICATIONS

The aim of treatment is pain relief and improvement or maintenance of the patient's functional status. Long term results were often not available and complications varied by study (frequently they were not reported) in the literature available for this guideline. 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

Each recommendation in this clinical practice guideline is based on a systematic review of the relevant medical literature. We developed systematic reviews for this guideline because these reviews employ specific processes designed to minimize bias in the selection, summary, and analysis of this literature.[6, 7] In referring to bias, we explicitly mean both the biases that can arise from financial conflicts of interest and biases that can arise from intellectual conflicts if interest.

This section of the present document describes how we conducted our systematic reviews and how the guideline was developed. Accordingly, in this section we describe our strategies for finding relevant literature, our criteria for selecting articles to include in this guideline, how we extracted data, how we appraised and graded the evidence, our methods of statistical analysis, and the review and approval steps this guideline went through. Elsewhere in this document, we provide extensive documentation so that interested readers can assure themselves that we attempted to combat bias wherever possible.

This guideline and the underlying systematic reviews were prepared by an AAOS physician 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). The work group met on December 13, 2008 to establish the guideline's scope. The work group met again on July 31 and August 1, 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 III 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] should be done in [whom], [when], [where], and [how often or how long]. They function as questions for the systematic review that underpins each preliminary recommendation, and they do not function as final recommendations or conclusions. Preliminary recommendations do not need to be true.

Once established, these *a priori* preliminary recommendations cannot be modified until the final work group meeting. The *a priori* and inviolate nature of the preliminary recommendations combats bias by preventing a "change in course" if a systematic review yields results that are not to someone's liking. The results of each systematic review are presented and discussed at the final work group meeting. At this time the preliminary recommendations are modified in response to the evidence in the systematic review. All

of the systematic reviews conducted for a given guideline are presented in it and, in general, all preliminary recommendations are modified.

## STUDY INCLUSION 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 Achilles tendon rupture. Acute Achilles tendon ruptures are defined as a rupture treated within zero to six weeks post injury.
- 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 study
- 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
- Enrolled a patient population comprised of at least 80% of patients with acute Achilles tendon rupture
- Reported quantified results
- Must have followed 50% or more of its patients on at least one outcome; if less than 80% follow up the outcome was down graded.
- Study must use validated outcome measures

When considering studies for inclusion, we included only the best available evidence. Accordingly, we first included Level I evidence. In the absence of two or more studies of this Level, we sequentially searched for and included Level II through Level IV evidence, and did not proceed to a lower level if there were two or more studies of a higher level. For example, if there were two Level II studies that addressed a recommendation, we did not include Level III or IV studies.

## OUTCOMES CONSIDERED

Clinical studies often report many different outcomes. We included only patient-oriented outcomes when they were available. As the term implies, patient-oriented outcomes are

outcomes that matter to the patient. "They tell clinicians, directly and without the need for extrapolation, that a diagnostic, therapeutic, or preventive procedure helps patients live longer or live better."[8] Examples of patient-oriented outcomes include pain and quality of life.

We included surrogate outcomes only when patient-oriented outcomes were not available. Surrogate outcomes are laboratory or other measurements that are used as substitutes for how a patient feels, functions, or survives.[9] Radiographic results are an example of a surrogate outcome.

We only included data for an outcome if ≥ 50% of the patients were followed for that outcome. For example, some studies report short-term outcomes data on nearly all enrolled patients, and report longer-term data on less than half of the enrolled patients. In such cases, we did not include the longer-term data. Additionally, we downgraded the Level of Evidence by one in instances where 50% to ≤80% of patients were followed. For example, if an otherwise perfect randomized controlled trial reported data on all enrolled patients one week after patients received a treatment but reported data on only 60% of patients one year later, we considered data from the later follow-up time as Level II evidence.

We only included data for outcomes reporting the average length of time to return to an activity if >80 % of the patients were included in the calculation. For example, some studies report the mean time for return to work as 6 weeks but are only including data for patients who have actually returned to work and are ignoring patients who are unable to return. An outcome such as this would not be included.

## 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 2009. Strategies for searching electronic databases were constructed by a Medical Librarian and reviewed by the work group. The search strategies we used are provided in Appendix IV. We searched six electronic databases; PubMed, EMBASE, CINAHL, The Cochrane Library, The National Guidelines Clearinghouse and TRIP database.

All searches of electronic databases were supplemented with manual screening of bibliographies of all retrieved publications. We also searched the bibliographies of recent systematic reviews and other review articles for potentially relevant citations. Finally, a list of potentially relevant studies not identified by our searches was provided by the work group members. Fifty-six studies met the inclusion criteria and were included.

A study attrition diagram (provided in Appendix V) documents, for each recommendation, the number of articles we identified, where we identified these articles, the number of articles we included, and the number of articles we excluded.

## DATA EXTRACTION

Data elements extracted from studies were defined in consultation with the physician work group. Two analysts completed data extraction independently for all studies. The evidence tables were audited by the work group. Disagreements about the accuracy of extracted data were resolved by consensus. The elements extracted are provided in Appendix VI.

The use of extracted data in our systematic reviews is another of our methods to combat bias. It ensures that our results are based on the numerical results reported in published articles and not on the authors' conclusions in the "Discussion Sections" of their articles. Such author conclusions can be influenced by bias.

## 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.

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[10] as well as others.[11]

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, all results presented in retrospective comparative and case-control studies were initially categorized as Level III, and all results presented in case-series reports were initially categorized as Level IV. 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 (Appendix VII).

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. 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 VII). 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.

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.

## DEFINING THE STRENGTH OF THE RECOMMENDATIONS

Judging the quality of evidence is only a stepping stone towards arriving at the strength of the 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 the recommendation takes into account the quality, quantity, and applicability of the available evidence. Strength of the recommendation 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.

The strength of a 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 rated as "strong" and recommendations based on the latter kind of evidence are given strength of recommendation of "weak".

To develop the strength of a recommendation, AAOS staff first assigned a preliminary strength rating for each recommendation that took only the quality and quantity of the available evidence into account (see Table 1). Work group members then modified the preliminary strength rating using the 'Form for Assigning Grade of Recommendation (Interventions)' shown in Appendix VIII. This form is based on recommendations of the GRADE Working group[10] and requires the work group to consider the harms, benefits, and critical outcomes associated with a treatment. It also requires the work group to evaluate the applicability of the evidence. The final strength of the recommendation is

assigned by the physician work group, which modifies the preliminary strength rating on the basis of these considerations.

**Table 1 Defining the Strength of the Recommendation**

| Strength | Overall Quality of Evidence | Description of Evidence |
|---|---|---|
| **Strong** | Good Quality Evidence | Level I evidence from more than one study with consistent findings for recommending for or against the intervention or diagnostic. |
| **Moderate** | Fair Quality Evidence | Level II or III evidence from more than one study with consistent findings, or Level I evidence from a single study for recommending for or against the intervention or diagnostic. |
| **Weak** | Poor Quality Evidence | Level IV or V evidence from more than one study with consistent findings, or Level II or III evidence from a single study for recommending for against the intervention or diagnostic. |
| **Inconclusive** | No Evidence or Conflicting Evidence | The evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention or diagnostic. |
| **Consensus** | No Evidence | There is no supporting evidence. In the absence of reliable evidence, the work group is making a recommendation based on their clinical opinion considering the known harms and benefits associated with the treatment. |

Each recommendation was written using language that accounts for the final strength of the recommendation. This language, and the corresponding strength of recommendation, is shown in Table 2.

**Table 2 AAOS Guideline Language**

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

## CONSENSUS DEVELOPMENT

The recommendations and their strength were voted on using a structured voting technique known as the nominal group technique.[12] We present details of this technique in Appendix . 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, we report the results of the statistical analyses conducted by the authors of the included studies. In some circumstances, statistical testing was not conducted; however, the authors reported sufficient quantitative data, including measures of dispersion or patient level data for statistical testing. In these circumstances we used the statistical program STATA (StatCorp LP, College Station, Texas) to conduct our own analysis to interpret the results of a study. P-values $< 0.05$ were considered statistically significant. Any statistical analysis conducted by the AAOS authors is denoted in the tables.

STATA was also used to determine 95% confidence intervals, using the method of Wilson, when authors of the included studies reported counts or proportions. The program was also used to determine the magnitude of the treatment effect. For data reported as means (and associated measures of dispersion) we calculated a standardized mean difference by the method of Hedges and Olkin.[13] For proportions, we calculated the odds ratio 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 ($p < 0.05$).[14]

We used the program TechDig 2.0 (Ronald B. Jones, Mundelein, Illinois) to estimate means and variances from studies presenting data only in graphical form.

When published studies only reported the median, range, and size of the trial, we estimated their means and variances according to a published method.[15]

## PEER REVIEW

The draft of the guideline and evidence report were peer reviewed by outside specialty organizations that were nominated by the physician work group prior to the development of the guideline. Peer review was accomplished using a structured peer review form (Appendix X).

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 38 peer reviewers and 17 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 (Appendix X).

Peer review of an AAOS guideline does not imply endorsement. This is clearly stated on the structured review form sent to all peer reviewers and is also posted within the guideline. Endorsement cannot be solicited during the peer review process because the documents may 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 members who participate on the work group or 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 submitted for 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 the development of this guideline. Of these, 4 returned public comments.

For this guideline, outside specialty societies could post the confidential draft of the guideline to their "member only" website. The responses garnered from these postings were compiled by the specialty society and submitted as one succinct public commentary. In addition, members of the AAOS 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 opportunity to comment on this guideline exceeds the number of public commentators for previously published AAOS guidelines as well as the numbers listed above.

## THE AAOS GUIDELINE APPROVAL PROCESS

In response to the non-editorial comments submitted during the period of public commentary, the draft was again modified by the AAOS Clinical Practice Guidelines Unit and physician work group members. The AAOS Guidelines and Technology Oversight Committee, the AAOS Evidence-based Practice Committee, the AAOS Council on Research, Quality Assessment, and Technology, and the AAOS Board of Directors approved the final guideline draft. Descriptions of these bodies are provided in Appendix III.

## 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 this new evidence, changing practice, rapidly emerging treatment options, and 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 the AAOS include submitting the guideline to the National Guideline Clearinghouse and distributing the guideline at other medical specialty societies' meetings.

# III. **RECOMMENDATIONS AND SUPPORTING EVIDENCE**

## RECOMMENDATION 1

In the absence of the reliable evidence, it is the opinion of this work group that a detailed history and physical exam be performed. The physical examination should include two or more of the following tests to establish the diagnosis of acute Achilles tendon rupture:

- Clinical Thompson test (Simmonds squeeze test)
- Decreased ankle plantar flexion strength
- Presence of a palpable gap (defect, loss of contour)
- Increased passive ankle dorsiflexion with gentle manipulation

AAOS Strength of Recommendation - **Consensus**

**Rationale:**

A systematic review of the literature did not identify adequate evidence for or against the use of specific history and physical examination findings to confirm the diagnosis of acute Achilles tendon rupture. There was only one level V study[16] identified that did not provide adequate data in support of any individual or combination of the physical tests.

The prompt and accurate diagnosis of acute Achilles tendon rupture is essential to providing patients with timely, effective, and appropriate care. A history and physical examination adds no cost or risk to patients. The work group therefore agreed that an opinion-based recommendation is warranted.

**Supporting Evidence:**

One Level V prospective study that enrolled patients with unilateral complete Achilles tendon tears was included.[16]

**SUMMARY OF EVIDENCE**

The study[16] used visual inspection at surgery as the gold standard for the diagnosis in patients who had open repair. The study author also used clinical exam, ultrasound and MRI as the reference standard for diagnosis when deciphering if patients had an Achilles tendon tear and to confirm the extent of the tear in patients treated non-operatively. Healthcare providers were not routinely blinded to the results of any given test. All patients received a physical examination; palpation (presence of a gap) and the calf squeeze test (Thompson/Simmonds squeeze test) were performed by the author in all patients. The author performed the Matles test (increased passive ankle dorsiflexion) on 107 of 174 patients.

The study author reported sensitivities and specificities for the tests based on the 133 patients treated with open repair and the 28 patients treated who did not have an Achilles tendon rupture. The author reported these test results individually. He did not consider if incremental value exists for any combination of the given physical tests when the tests are all performed during the physical examination.

## EXCLUDED ARTICLES

**Table 3. Excluded Articles**

| Author | Title | Exclusion Reason |
|---|---|---|
| Copeland SA; | Rupture of the Achilles tendon: a new clinical test | Not relevant |
| Matles AL | Rupture of the tendo achilles: another diagnostic sign | Commentary |

**STUDY QUALITY**

**Table 4. Study Quality**

| ● = Yes ○ = No X = Not Reported n/a = not applicable | | | | Spectrum bias avoided | Selection criteria described | Appropriate reference standard | Disease progression bias avoided | Partial verification bias avoided | Differential verification bias avoided | Incorporation bias avoided | Index test execution described | Reference standard execution described | Test review bias avoided | Diagnostic review bias avoided | Clinical review bias avoided | Uninterruptable/Intermediate test result(s) reported | Withdrawals explained |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Author | N | Index Test | Reference Standard | | | | | | | | | | | | | | |
| Maffulli | 161 | Palpation | Open Repair,Ultrasound or MRI or Clinical tests | X | ○ | ● | ● | ● | ○ | ● | ● | ● | ● | ○ | ● | ● | ● |
| Maffulli | 161 | Calf Squeeze Test (Thompson test/Simmonds squeeze test) | Open Repair, Ultrasound or MRI or Clinical tests | X | ○ | ● | ● | ● | ○ | ● | ● | ● | ● | ○ | ● | ● | ● |
| Maffulli | 105 | Matles Test (increased passive ankle dorsiflexion) | Open Repair, Ultrasound or MRI or Clinical tests | X | ○ | ● | ● | ● | ○ | ● | ● | ● | ● | ○ | ● | ● | ○ |

**STUDY RESULTS**

**Table 5. Sensitivity and specificity of Palpation, Calf Squeeze and Matles tests**

| Author | N | Test | Sensitivity‡ (95% CI) | Specificity‡ (95% CI) |
|---|---|---|---|---|
| Maffulli | 161 | Palpation (presence of a gap) | 0.73 (0.65, 0.80) | 0.89 (0.72, 0.98) |
| Maffulli | 161 | Calf Squeeze Test (Thompson test / Simmonds squeeze test) | 0.96 (0.91, 0.99) | 0.93 (0.76, 0.99) |
| Maffulli | 105 | Matles Test (increased passive ankle dorsiflexion) | 0.88 (0.79, 0.95) | 0.86 (0.67, 0.96) |

‡ AAOS Calculation

## RECOMMENDATION 2

We are unable to recommend for or against the routine use of magnetic resonance imaging (MRI), ultrasound (ultrasonography), and radiograph (roentgengrams, x-rays) to confirm the diagnosis of acute Achilles tendon rupture.

AAOS Strength of Recommendation – **Inconclusive**

**Rationale:**

A systematic review of the literature failed to identify adequate evidence to make a recommendation for or against the routine use of MRI, ultrasound, or radiographs to confirm the diagnosis of acute Achilles tendon rupture.

There were no studies that address MRI or radiographs as confirmatory tests and there were only two level V studies[16, 17] that addressed ultrasound. These two studies contain unreliable data and cannot be combined to provide adequate evidence.

**Supporting Evidence:**

No studies were identified to adequately answer this recommendation. To answer this recommendation the ideal study must investigate the incremental benefit added by one of the specified technologies (MRI, Ultrasound or plain radiograph). We found no studies that addressed MRI or plain radiographs as a confirmatory test. Studies were found that addressed ultrasound but they did not adequately address the recommendation using the necessary study design.

The ideal study design required to address this recommendation compares two groups of patients. Group one patients undergo the Thompson test and then surgery (gold standard). Group two patients undergo the Thompson test and the test of interest (MRI, ultrasound, or plain radiographs) and then surgery. Sensitivity, specificity and likelihood ratios would be calculated and compared between groups to determine the incremental benefit added by the technology. No study included both of the groups.

## SUMMARY OF EVIDENCE

Two Level V prospective studies that enrolled patients with complete Achilles tendon tears were found.[16, 17] The studies used visual inspection at surgery as the gold standard for the diagnosis. One study had patients that underwent the Thompson test and then surgery. Patients in the second study underwent the Thompson test and Ultrasound and then surgery. The authors of the studies reported sensitivities and specificities or provided enough information for these parameters to be determined.

## EXCLUDED ARTICLES

**Table 6. Excluded Articles**

| Author | Title | Exclusion Reason |
|---|---|---|
| Fornage, 1986 | Achilles tendon: US examination | Less than 10 patients per group |
| Haims, et al. 2000 | MR imaging of the Achilles tendon: overlap of findings in symptomatic and asymptomatic individuals | Does not investigate the diagnostic test |
| Hartgerink, et al. 2001 | Full- versus partial-thickness Achilles tendon tears: sonographic accuracy and characterization in 26 cases with surgical correlation | Retrospective Chart Review |
| Hollenberg, et al. 2000 | Sonographic appearance of nonoperatively treated Achilles tendon ruptures | Does not investigate the diagnostic test |
| Kabbani, et al. 1993 | Magnetic resonance imaging of tendon pathology about the foot and ankle. Part I. Achilles tendon | Commentary |
| Kalebo, et al. 1992 | Diagnostic value of ultrasonography in partial ruptures of the Achilles tendon | Chronic/neglected Achilles tendon rupture |
| Kayser, et al. 2005 | Partial rupture of the proximal Achilles tendon: a differential diagnostic problem in ultrasound imaging | Partial Rupture |
| Kuwada, 2008 | Surgical correlation of preoperative MRI findings of trauma to tendons and ligaments of the foot and ankle | Less than 10 patients per group |
| Lehtinen, et al. 1994 | Sonography of Achilles tendon correlated to operative findings | Chronic/neglected Achilles tendon rupture |
| Marshall, et al. 2002 | Contrast-enhanced magic-angle MR imaging of the Achilles tendon | Less than 10 patients per group |
| Mathieson, et al. 1988 | Sonography of the Achilles tendon and adjacent bursae | Less than 10 patients per group |
| Paavola, et al. 1998 | Ultrasonography in the differential diagnosis of Achilles tendon injuries and related disorders. A comparison between pre-operative ultrasonography and surgical findings | Retrospective Chart Review |

**STUDY QUALITY**

**Table 7. Study Quality**

| ● = Yes ○ = No X = Not Reported<br>n/a = not applicable | | | | Spectrum bias avoided | Selection criteria described | Appropriate reference standard | Disease progression bias avoided | Partial verification bias avoided | Differential verification bias avoided | Incorporation bias avoided | Index test execution described | Reference standard execution described | Test review bias avoided | Diagnostic review bias avoided | Clinical review bias avoided | Uninterruptable/Intermediate test result(s) reported | Withdrawals explained |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Author | N | Index Test | Reference Standard | | | | | | | | | | | | | | |
| Maffulli | 161 | Calf Squeeze Test (Thompson test/Simmonds squeeze test) | Open Repair | X | ○ | ● | ● | ● | ○ | ● | ● | ● | ● | ○ | ● | ● | ● |
| Margetic | 88 | Calf Squeeze Test (Thompson test/Simmonds squeeze test) plus Ultrasound | Surgery | X | ○ | ● | ● | ● | ○ | ● | ● | ● | ○ | ○ | ● | ● | ○ |

**STUDY RESULTS**

**Table 8. Sensitivity and Specificity**

| Author | N | Test | Sensitivity (95% CI) | Specificity (95% CI) |
|---|---|---|---|---|
| Maffulli | 161 | Calf Squeeze Test (Thompson test / Simmonds squeeze test) | 0.96 (0.91, 0.99) | 0.93 (0.76, 0.99) |
| Margetic et. al. | 88 | Calf Squeeze Test (Thompson test / Simmonds squeeze test) plus ultrasound | 0.91 (0.83, 0.96) | 1.00 (0.16, 1.00) |

## RECOMMENDATION 3

Non-operative treatment is an option for patients with acute Achilles tendon rupture.

AAOS Strength of Recommendation: **Weak**

**Rationale:**

A systematic review of non-operative treatment compared to operative treatment of acute Achilles tendon ruptures identified four level II studies including all operative techniques.[18-21] Three studies included standard open treatment and one included a minimally invasive technique. Increased complications were noted in the open operative group.

When the outcomes of open and minimally invasive techniques were considered separately, the preliminary strength of recommendation was moderate. The group agreed that it was important to evaluate both functional outcomes and complications comparing non-operative and all operative treatment groups. When these heterogeneous groups were separated into non-operative and operative (including minimally invasive) treatments, the strength of recommendation was downgraded to weak.

The functional outcomes were favorable in the operative group in 1 of 2 level II studies and the return to activity and sport in 1 of 3 level II studies. Only 1 of 4 studies demonstrated improvement in the rerupture rate in the operative group. The remainder of the studies demonstrated no difference between the groups.

Higher complication rates, primarily due to impaired wound healing in the operative group, demonstrate the importance of awareness of surgical risk factors in the decision making of operative versus non-operative treatment (see Recommendation 6).

With acceptable functional results and lower complication rates than operative treatment, non-operative treatment of acute Achilles tendon ruptures is an option in all patients, especially those with increased surgical risk factors.

**Supporting Evidence:**

To address this recommendation, we analyzed studies that made two different comparisons. Three level II studies compared patients treated non-operatively (with casting) to patients treated with open repair and one level II study compared casting to minimally invasive open repair.[18-21]

Two studies examined functional outcomes and both found non-significant results (Table 9). Based on AAOS calculations, one of these studies did have significant results at two, three, and six months measured by the Musculoskeletal Functional Assessment Index (MFAI) in which patients with operative treatment had better functional ability than those treated non-operatively; our results differ from the authors because a higher powered statistical test was used. Two studies reported no significant difference in the number of patients with pain (see Table 10).

Three studies reported patients treated non-operatively did not significantly differ in the amount of time to return to work (see Table 11). Three studies examined return to sports and one reported significant results in favor of patients treated with operative repair (see Table 12). One study reported significantly less reruptures in patients treated operatively (see Table 13).The occurrence of extreme residual tendon lengthening, DVT, and "major" complications were not significantly different between patients treated operatively or non-operatively. Minor complications reported in the included studies were related to the surgical intervention and therefore occurred less in patients treated non-operatively (see Table 15).

## SUMMARY OF EVIDENCE

**Table 9. Operative vs. Cast – Function**

| Author | Comparison | Outcome | LOE | N | Duration (Months) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2 weeks | 2 | 3 | 6 | 12 |
| Twaddle | Open vs. Cast | MFAI‡ | II | 42 | ○ | ●Op | ●Op | ●Op | ○ |
| Cetti | Open vs. Cast | Function | II | 111 | | | | | ○ |

‡Musculoskeletal Functional Assessment Index
●Op: Statistically Significant in Favor of Operative Repair
●Non-Op: Favors Non-Operative treatment with Cast
○ No statistical significance

**Table 10. Operative vs. Cast – Pain**

| Author | Comparison | Outcome | LOE | N | Duration (Months) | | |
|---|---|---|---|---|---|---|---|
| | | | | | 2 | 3 | 12 |
| Möller | Open vs. Cast | % w/ Pain‡ | III | 85 | | | ○ |
| Metz | Minimally Invasive vs. Cast | Pain (VAS) | II | 83 | ○ | ○ | ○ |

‡Level III evidence due to less than 80% of patients at follow-up
●Op: Statistically Significant in Favor of Operative Repair
●Non-Op: Favors Non-Operative treatment with Cast
○ No statistical significance

**Table 11. Operative vs. Cast – Return to Work**

| Author | Comparison | Outcome | LOE | N | Duration (Months) | |
|---|---|---|---|---|---|---|
| | | | | | 12 | 24 |
| Cetti | Open vs. Cast | Sick Leave | II | 111 | ○ | |

| Author | Comparison | Outcome | LOE | N | Duration (Months) | |
|---|---|---|---|---|---|---|
| | | | | | 12 | 24 |
| Möller | Open vs. Cast | Sick Leave | II | 112 | | ○ |
| Metz | Minimally Invasive vs. Cast | Return to Work | II | 78 | | ○ |

●Op: Statistically Significant in Favor of Operative Repair
●Non-Op: Favors Non-Operative treatment with Cast
○ No statistical significance

**Table 12. Operative vs. Cast - Return to Sport**

| Author | Comparison | Outcome | LOE | N | Duration (Months) | |
|---|---|---|---|---|---|---|
| | | | | | 12 | 24 |
| Cetti | Open vs. Cast | Return to Sport | II | 111 | ●Op | |
| Möller | Open vs. Cast | Return to Sport | II | 112 | | ○ |
| Metz | Minimally Invasive vs. Cast | Return to Sport (%) | II | 69 | ○ | |

●Op: Statistically Significant in Favor of Operative Repair
●Non-Op: Favors Non-Operative treatment with Cast
○ No statistical significance

**Table 13. Operative vs. Cast - Rerupture**

| Author | Outcome | LOE | N | Duration (Months) |
|---|---|---|---|---|
| | | | | 12 |
| Twaddle | Rerupture | II | 42 | ○ |
| Cetti | Rerupture | II | 111 | ○ |
| Möller | Rerupture | II | 112 | ●Op |
| Metz | Rerupture | II | 83 | ○ |

●Op: Statistically Significant in Favor of Operative Repair
●Non-Op: Favors Non-Operative treatment with Cast
○ No statistical significance

**Table 14. Operative vs. Cast - Satisfaction**

| Author | Comparison | Outcome | LOE | N | Duration (Months) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2 | 3 | 6 | 12 | 24 |
| Möller | Open Repair vs. Cast | Satisfaction‡ (VAS) | III | 85 | ●Op | | ●Op | ●Op | ●Op |
| Metz | Minimally Invasive vs. Cast | Satisfaction (VAS) | II | 83 | ○ | ○ | | ○ | |

‡Level III evidence due to less than 80% of patients at follow-up
●Op: Statistically Significant in Favor of Operative Repair
●Non-Op: Favors Non-Operative treatment with Cast
○ No statistical significance

**Table 15. Operative vs. Cast – Complications**

| Author | Adverse event/ Complication | LOE | N | Duration (Months) |
|---|---|---|---|---|
| | | | | 12 |
| Cetti | Major Complications - (not including rerupture) | II | 111 | ○ |
| Metz | Total Complications | II | 83 | ○ |
| Möller | Extreme Residual Tendon Lengthening | II | 112 | ○ |
| Möller | DVT | II | 112 | ○ |
| Cetti | Total - Minor Complications‡ | II | 111 | ●Non-Op |
| Metz | Partial Sensibility | II | 83 | ●Non-Op |
| Cetti | Disturbances of Sensibility | II | 111 | ○ |
| Möller | Disturbance of Sensitivity | II | 112 | ○ |
| Metz | Scar Adhesions | II | 83 | ●Non-Op |
| Möller | Scar Adhesions | II | 112 | ●Non-Op |
| Cetti | Suture granuloma | II | 111 | ○ |
| Möller | Superficial infection | II | 112 | ○ |

‡As defined by the author: "Differences between major/minor complications is that major complications give functional discomfort." Minor Complications include: Scar adhesions, superficial infection, disturbances of sensibility, suture granuloma, delayed wound healing.
●Op: Statistically Significant in Favor of Operative Repair

●Non-Op: Statistically Significant in Favor of Non-Operative treatment with Cast
○ No statistical significance

**Summary of Systematic Reviews**

**Table 16. Systematic Review Summary**

| Author | Conclusion |
|---|---|
| Bhandari, M et al. 2002 | "Deep venous thrombosis is more common after nonoperative treatment of Achilles tendon ruptures" (p. 195). |
| Bhandari, M et al. 2002 | "…The current group of randomized trials suggests a benefit to surgical repair of acute Achilles tendon ruptures in younger, active patients" (p. 199). |
| Bhandari, M et al. 2002 | "Pooled analysis of studies did not reveal any difference in the risk of minor complaints or return to normal function between surgical repair and conservatively treated groups" (p. 190). |
| Bhandari, M et al. 2002 | "Surgical treatment significantly reduces the risk of Achilles tendon re-ruptures, but increases the risk of infection, when compared with conservative therapy" (p. 190). |
| Khan, RJK, et al. 2005 | "In conclusion, open operative treatment of acute Achilles tendon ruptures significantly reduces the risk of re-rupture compared with nonoperative treatment but has the drawback of a significantly higher risk of other complications, including wound infection" (p.2209). |
| Lo, IKY, et al. 1997 | "Although operative treatment provides a reduced re-rupture rate over nonoperative treatment, the rate of moderate and mild complications in operative treatment is 20 times greater" (p. 211). |
| Lo, IKY, et al. 1997 | "Presently, we favor non-operative treatment in patients with poor healing potential (i.e., smokers, diabetics, and patients with peripheral vascular disease)" (p. 211). |
| Lo, IKY, et al. 1997 | "For healthy active individuals, we offer both forms of treatment, providing the patients with the estimates of treatment success and complication rates" (p. 211). |
| Lynch, RM 2004 | "Surgical treatment is preferable to non-surgical treatment, produces better functional outcomes, and therefore appears to be the treatment of choice" (p. 156). |
| Lynch, RM 2004 | "The incidence of re-rupture following non-surgical treatment is significantly higher than for surgical treatment" (p. 156). |
| Lynch, RM 2004 | "The number of patients that need to be treated surgically to prevent one re-rupture if these patients were treated non-surgically is 5 (3-13, 95% confidence intervals)" (p.156). |
| Lynch, RM 2004 | "The incidence of minor complications following surgical treatment is large, but these do not appear to affect functional outcome" (p. 156). |

| Author | Conclusion |
|---|---|
| Lynch, RM 2004 | "Non-surgical treatment should be reserved for patients who refuse or who are unfit for operative repair" (p. 156). |

## EXCLUDED ARTICLES

**Table 17. Excluded Articles**

| Author | Title | Exclusion Reason |
|---|---|---|
| Doral, et al. 2009 | Percutaneous suturing of the ruptured Achilles tendon with endoscopic control | Not best available evidence - not comparative |
| Neumayer, et al. 2009 | A new conservative-dynamic treatment for the acute ruptured Achilles tendon | Not best available evidence - not comparative |
| Ebinesan, et al. 2008 | Conservative, open or percutaneous repair for acute rupture of the Achilles tendon | Not best available evidence - retrospective comparative |
| Lorkowski, et al. 2007 | Evaluation of long term therapy outcomes for Achilles tendon ruptures | Combines operative and non-operative patients |
| Kotnis, et al. 2006 | Dynamic ultrasound as a selection tool for reducing Achilles tendon re-ruptures | Not best available evidence |
| van, et al. 2004 | Results of surgical versus non-surgical treatment of Achilles tendon rupture | Not best available evidence |
| Weber, et al. 2003 | Non-operative treatment of acute rupture of the Achilles tendon. results of a new protocol and comparison with operative treatment | Not best available evidence - retrospective comparative |
| Follak, et al. 2002 | The utility of gait analysis in the rehabilitation of patients after surgical treatment of Achilles tendon rupture | Not best available evidence - not comparative |
| Moller, et al. 2002 | Calf muscle function after Achilles tendon rupture. A prospective, randomised study comparing surgical and non-surgical treatment | Duplicate - Data reported in prior study |
| Rumian, et al. 2001 | Surgical repair of the Achilles tendon. The lateral approach | Not best available evidence - not comparative |
| Horstmann, et al. 2000 | Isokinetic strength and strength endurance of the lower limb musculature ten years after Achilles tendon repair | Not best available evidence - not comparative |
| Rowley, et al. 1982 | Rupture of the Achilles tendon treated by a simple operative procedure | No patient oriented outcome |
| Inglis, et al. 1976 | Ruptures of the tendo achillis. An objective assessment of surgical and non-surgical treatment | Less than 10 patients per group |
| Nistor, et al. 1981 | Surgical and non-surgical treatment of Achilles Tendon rupture. A prospective randomized study | Not best available evidence |

| Author | Title | Exclusion Reason |
|---|---|---|
| Jacobs, et al. 1978 | A new conservative-dynamic treatment for the acute ruptured Achilles tendon | Combines acute and neglected/chronic Achilles tendon tear patients |

## STUDY QUALITY

**Table 18. Study Quality**

| ● = Yes ○ = No × = Not Reported | | | | | Stochastic Randomization | Allocation Concealment | Patients Blinded | Those rating outcome Blinded | Follow Up - 80% or more | All groups have similar outcome performance at entry |
|---|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome** | **N** | **Treatment(s)** | **Level of Evidence** | | | | | | |
| Twaddle | MFAI | 42 | Operative vs. Cast | Level II | ● | ● | ○ | ● | ● | × |
| Twaddle | Re-rupture | 42 | Operative vs. Cast | Level II | ● | ● | ○ | ● | ● | × |
| Moller | Re-rupture | 112 | Operative vs. Cast | Level II | ● | ● | ○ | ● | ● | ● |
| Moller | Return to work | 112 | Operative vs. Cast | Level II | ● | ● | ○ | ● | ● | ● |
| Moller | Quality of Life (VAS) | 112 | Operative vs. Cast | Level II | ● | ● | ○ | ● | ● | ● |
| Moller | Treatment Results (VAS) | 112 | Operative vs. Cast | Level II | ● | ● | ○ | ● | ● | ● |
| Moller | Pain | 85 | Operative vs. Cast | Level III | ● | ● | ○ | ● | ○ | ● |
| Cetti | Return to Work | 111 | Operative vs. Cast | Level II | × | × | ○ | ● | ● | ● |
| Cetti | Return to Sports | 111 | Operative vs. Cast | Level II | × | × | ○ | ● | ● | ● |
| Cetti | Hospitalization | 111 | Operative vs. Cast | Level II | × | × | ○ | ● | ● | ● |
| Metz | Re-rupture | 83 | Operative vs. Cast | Level II | ○ | ○ | × | × | ● | × |
| Metz | Return to work | 83 | Operative vs. Cast | Level II | ● | ● | ○ | ● | ● | ● |
| Metz | Return to sport | 83 | Operative vs. Cast | Level II | ● | ● | ○ | ● | ● | ● |
| Metz | Pain- VAS | 83 | Operative vs. Cast | Level II | ● | ● | ○ | ● | ● | × |
| Metz | Satisfaction - VAS | 83 | Operative vs. Cast | Level II | ● | ● | ○ | ● | ● | × |

**STUDY RESULTS**

**Table 19. Open vs. Cast - Function**

| Author | Comparison | Outcome | LOE | N | Duration | Open Repair | Cast | Results |
|---|---|---|---|---|---|---|---|---|
| | | | | | | mean (SD) % | mean (SD) % | |
| Twaddle | Open vs. Cast | MFAI | II | 42 | 2 weeks | 42.4 (2.7)‡ | 43 (2.7)‡ | p = 0.48‡ |
| Twaddle | Open vs. Cast | MFAI | II | 42 | 2 months | 23.7 (2.6)‡ | 27.6 (3.4)‡ | p = 0.002‡ |
| Twaddle | Open vs. Cast | MFAI | II | 42 | 3 months | 15.2 (2.1)‡ | 17 (2.6)‡ | p = 0.02‡ |
| Twaddle | Open vs. Cast | MFAI | II | 42 | 6 months | 7.8 (2.1)‡ | 10.4 (2.2)‡ | p = 0.004‡ |
| Twaddle | Open vs. Cast | MFAI | II | 42 | 12 months | 3.4 (1.7)‡ | 4.2 (1.7)‡ | p = 0.14‡ |
| Cetti | Open vs. Cast | Function - Abnormal Gait | II | 111 | 12 months | 5.4% | 3.6% | NS |
| Cetti | Open vs. Cast | Function – Abnormal Run | II | 111 | 12 months | 12.5% | 18.2% | NS |
| Cetti | Open vs. Cast | Function - Abnormal Toe Stand | II | 111 | 12 months | 8.9% | 9.1% | NS |

‡ AAOS Calculation

NS: No statistical significance; authors do not report p-value.

**Table 20. Cast vs. Open Repair - Pain**

| Author | Comparison | Outcome | LOE | N | Duration | Open Repair | Minimally Invasive | Cast | Results |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | mean (SD) % | mean (SD) % | mean (SD) % | |
| Möller | Open vs. Cast | Pain - None | III | 85 | 12 months | 92% | n/a | 88% | p = .69‡ |
| Möller | Open vs. Cast | Pain - Moderate | III | 85 | 12 months | 6% | n/a | 3% | p = .55‡ |
| Möller | Open vs. Cast | Pain - During Walking | III | 85 | 12 months | 2% | n/a | 9% | p = .129‡ |
| Metz | Minimally Invasive vs. Cast | Pain (VAS)‡ | II | 83 | 2 months | n/a | 1.80 (1.40)‡ | 1.56 (1.25)‡ | p = 0.20‡ |

| Author | Comparison | Outcome | LOE | N | Duration | Open Repair | Minimally Invasive | Cast | Results |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | mean (SD) % | mean (SD) % | mean (SD) % | |
| Metz | Minimally Invasive vs. Cast | Pain (VAS) | II | 83 | 3 months | n/a | 1.53 (1.71)‡ | 1.80 (1.40)‡ | p = 0.78‡ |
| Metz | Minimally Invasive vs. Cast | Pain (VAS) | II | 83 | 12 months | n/a | 0.40 (0.93)‡ | 0.78(1.40)‡ | p = 0.92‡ |

‡ AAOS Calculation
NS: No statistical significance; authors do not report p-value.
n/a: not applicable

**Table 21. Operative vs. Cast - Return to Work**

| Author | Comparison | Outcome | LOE | N | Duration | Open Repair | Minimally Invasive | Cast | Results |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | mean (SD) | mean (SD) | mean (SD) | |
| Cetti | Open vs. Cast | Return to Work (days) | II | 111 | 12 months | 43.4 (15.05) | n/a | 56 (25.2) | NS |
| Möller | Open vs. Cast | Sick Leave (days) | II | 111 | 24 months | 54.9 (47.9) | n/a | 73.4 (56.5) | p = 0.06 |
| Möller | Open vs. Cast | Return to heavy work (days) | II | 24 | 24 months | 102.2 (52.7) | n/a | 108.1(34.7) | NS |
| Möller | Open vs. Cast | Return to light work (days) | II | 54 | 24 months | 35.7 (38) | n/a | 67.2 (65.9) | p = 0.03 |
| Möller | Open vs. Cast | Return to Work – Sedentary (days) | II | 34 | 24 months | 30.8 (36.5) | n/a | 33.2 (54.7) | NS |
| Metz | Minimally Invasive vs. Cast | Return to Work (days) | II | 78 | 12 months | n/a | 59 (82) | 108 (115) | p < 0.05 |

‡ AAOS Calculation
NS: No statistical significance; authors do not report p-value.
n/a: not applicable

**Table 22. Operative vs. Cast - Return to Sport**

| Author | Comparison | Outcome | LOE | N | Duration | Open Repair % | Minimally Invasive % | Cast % | Results |
|---|---|---|---|---|---|---|---|---|---|
| Cetti | Open vs. Cast | Return to Sports-Total | II | 111 | 12 months | 79% | n/a | 64% | p = .21‡ |
| Cetti | Open vs. Cast | Return to Sport - Same Level | II | 111 | 12 months | 57% | n/a | 29% | p =.005 |
| Möller | Open vs. Cast | Return to Sport - Same Level | II | 112 | 12 months | 54% | n/a | 54% | NS |
| Cetti | Open vs. Cast | Return to Sport - Diminished | II | 111 | 12 months | 21% | n/a | 35% | NS |
| Cetti | Open vs. Cast | Return to Sport - Stopped | II | 111 | 12 months | 14% | n/a | 22% | NS |
| Möller | Open vs. Cast | Return to Sport - Stopped | II | 112 | 12 months | 16% | n/a | 14% | p = .620‡ |
| Metz | Minimally Invasive vs. Cast | Return to Sport | II | 69 | 12 months | n/a | 67% | 81% | p = 0.16 |

‡ AAOS Calculation
NS: No statistical significance; authors do not report p-value.
n/a: not applicable

**Table 23. Operative vs. Cast - Rerupture**

| Author | Complication | LOE | N | Duration | Open Repair % | Minimally Invasive % | Cast % | Results |
|---|---|---|---|---|---|---|---|---|
| Cetti | Rerupture | II | 111 | 12 months | 5.4% | n/a | 12.7% | p = .167‡ |
| Möller | Rerupture | II | 112 | 12 months | 1.7% | n/a | 20.8% | p = < .001 |
| Twaddle | Rerupture | II | 42 | 6 months | 10.0% | n/a | 4.5% | p = .49‡ |
| Metz | Rerupture | II | 83 | 12 months | n/a | 7.1% | 12.2% | p = 0.44‡ |
| Cetti | Second Rerupture | II | 111 | 12 months | 0.0% | n/a | 1.8% | p = .154‡ |

‡ AAOS Calculation
n/a: not applicable

**Table 24 Cast vs. Open - Complications**

| Author | Complications | LOE | N | Duration | Open Repair | Minimally Invasive | Cast | Results |
|---|---|---|---|---|---|---|---|---|
| | | | | | % | % | % | |
| Metz | Total Complications | II | 83 | 12 months | n/a | 28.6% | 48.8% | p = 0.06 |
| Cetti | Major Complications (not including rerupture) | II | 111 | 12 months | 9.0% | n/a | 16.3% | NS |
| Metz | Total Complications Other Than Rerupture | II | 83 | 12 months | n/a | 21.4% | 36.6% | p = 0.13 |
| Metz | Sural Nerve Injury | II | 83 | 12 months | n/a | 7.1% | 2.4% | p = 0.30‡ |
| Cetti | Deep Infection | II | 111 | 12 months | 3.6% | n/a | 0% | p = 0.05 |
| Metz | Deep Wound Infection | II | 83 | 12 months | n/a | 0 | 0.0% | NS |
| Cetti | Delayed Wound Healing | II | 111 | 12 months | 1.8% | n/a | 0% | p = 0.158‡ |
| Cetti | Disturbances of Sensibility | II | 111 | 12 months | 12.5% | n/a | 1.8% | p = 0.017‡ |
| Möller | Disturbance of Sensitivity | II | 112 | 24 months | 1.7% | n/a | 0% | p = 0.16‡ |
| Metz | Partial Sensibility | II | 83 | 12 months | n/a | 9.5% | 0.0% | p = 0.01‡ |
| Metz | DVT - lower leg | II | 83 | 12 months | n/a | 0.0% | 2.4% | p = 0.15‡ |
| Möller | DVT | II | 112 | 24 months | 0.0% | n/a | 1.9% | p = 0.14‡ |
| Cetti | Necrosis of the Skin | II | 112 | 12 months | 0.0% | n/a | 0% | NS |
| Cetti | Extreme Residual Tendon Lengthening | II | 111 | 12 months | 0.0% | n/a | 1.8% | p = 0.15‡ |
| Möller | Extreme Residual Tendon Lengthening | II | 112 | 24 months | 0.0% | n/a | 1.9% | p = 0.14‡ |
| Cetti | Total - Minor Complications | II | 111 | 12 months | 26.8% | n/a | 5.4% | p = 0.004 |
| Metz | Skin Related Complications | II | 83 | 12 months | n/a | 4.8% | 31.7% | p = .001‡ |
| Cetti | Scar Adhesions | II | 111 | 12 months | 10.7% | n/a | 3.6% | p = 0.136‡ |
| Metz | Scar Adhesions | II | 83 | 12 months | n/a | 7.1% | 0.0% | p = 0.01‡ |

| Author | Complications | LOE | N | Duration | Open Repair | Minimally Invasive | Cast | Results |
|---|---|---|---|---|---|---|---|---|
| | | | | | % | % | % | |
| Möller | Scar Adhesions | II | 112 | 24 months | 13.6% | n/a | 0% | p = <.001‡ |
| Cetti | Suture Granuloma | II | 111 | 12 months | 1.8% | n/a | 0% | p = 0.158‡ |
| Möller | Superficial Infection | II | 112 | 24 months | 1.7% | n/a | 0% | p = 0.16‡ |

‡ AAOS Calculation
NS: No statistical significance; authors do not report p-value.
n/a: not applicable

## RECOMMENDATION 4

For patients treated non-operatively, we are unable to recommend for or against the use of immediate functional bracing for patients with acute Achilles tendon rupture.

AAOS Strength of Recommendation**: Inconclusive**

**Rationale:**

Non-operative treatment for Achilles tendon ruptures was evaluated by comparing the use of immediate functional bracing or a combination of casting with functional bracing (for a period of 0-12 weeks) to casting alone. One level II and one level IV comparative study were analyzed. The only outcome that could be adequately determined in these studies was rerupture rate which was not significantly different. [22, 22]

Functional outcomes of the functional bracing group were analyzed with three studies (level IV and V) and no case series of cast treatment alone was identified. [23-25]

With the lack of functional data demonstrating improved outcomes with functional bracing and the lack of demonstrable difference in rerupture rates, we are unable to recommend for or against the use of immediate functional bracing for patients treated non-operatively for acute Achilles tendon rupture.

**Supporting Evidence:**

We analyzed one level II and one level IV study that compared patients treated with cast plus a functional brace vs. patients treated with a cast only. [26 22] We reported the rerupture rates of both comparative studies but other outcomes were considered due to the reliability of the evidence reported in both studies (See Methods Section – Outcomes considered). We then examined three studies (Level IV and V) that reported results for patients treated with functional bracing. [23-25]

In both comparative studies, rerupture rates did not significantly differ between patients treated with cast plus orthosis vs. cast (see Table 25). See Table 36 for case series re-rupture rates.

Seventy-eight percent of patients treated with a functional brace had no pain, 55% reported no stiffness, 56% had no weakness, 98% of patients returned to full level of employment and 37% returned to the same level of sports at 2.9 years. The average time to return to work was 7 days (range 21 – 52) (see Table 26).

One study reported 2% of patients had a pulmonary embolism and another study reported 1% of patients with a DVT and “temporary drop foot” (see Table 35).

## SUMMARY OF EVIDENCE

**Table 25. Cast + Functional Brace vs. Cast - Rerupture**

| Author | Outcome | LOE | N | Duration | Cast (%) | Cast + orthosis (%) | Results |
|---|---|---|---|---|---|---|---|
| Saleh, et al. 1992 | Rerupture | II | 31 | 12 months | 6% | 7% | p=.96‡ |
| Ingvar, et al. 2005 | Rerupture | IV | 194 | 4 years | 7% | 10% | p=.51‡ |

‡ AAOS calculation

**Table 26. Summary of Results - Case Series**

| Author | Outcome | LOE | N | Duration | Results (%) |
|---|---|---|---|---|---|
| Wallace | Pain - none | IV | 140 | 2.9 years | 78% |
| Wallace | Stiffness – none | IV | 140 | 2.9 years | 55% |
| Wallace | Weakness – none | IV | 140 | 2.9 years | 56% |
| Wallace | Return to Full Preinjury Level of Employment | IV | 122 | 2.9 years | 98% |
| Wallace, et al. 2004 | Return to Sports - same or better level | IV | 101 | 2.9 years | 37% |

**Table 27. Summary of Systematic Reviews**

| Author | Conclusion |
|---|---|
| Lynch, RM 2004 | "Early functional mobilisation is more acceptable to patients than plaster cast immobilisation and results in improved functional outcomes" (p. 156). |

**Table 28. Functional Bracing – Satisfaction (VAS)**

| Author | Outcome | LOE | N | Duration | Results (mean ± SD) |
|---|---|---|---|---|---|
| Neumayer, et al. 2009 | Satisfaction (VAS) | IV | 46 | 5 years | 8.1 ± 2 |

**Table 29. Functional Bracing - Satisfaction (%)**

| Author | Outcome | LOE | N | Duration | Results (%) |
|---|---|---|---|---|---|
| Wallace, et al. 2004 | Satisfaction – very satisfied | IV | 140 | 2.9 years | 83% |
| Wallace, et al. 2004 | Satisfaction – satisfied with minor reservations | IV | 140 | 2.9 years | 15% |
| Wallace, et al. 2004 | Satisfaction – satisfied with major reservations | IV | 140 | 2.9 years | 1% |
| Wallace, et al. 2004 | Satisfaction – dissatisfied | IV | 140 | 2.9 years | 1% |

**Table 30. Functional Bracing - Pain**

| Author | Outcome | LOE | N | Duration | Results (%) |
|---|---|---|---|---|---|
| Wallace, et al. 2004 | Pain - none | IV | 140 | 2.9 years | 78% |
| Wallace, et al. 2004 | Pain - mild | IV | 140 | 2.9 years | 13% |
| Wallace, et al. 2004 | Pain - moderate | IV | 140 | 2.9 years | 8% |
| Wallace, et al. 2004 | Pain – severe | IV | 140 | 2.9 years | 1% |

**Table 31. Functional Bracing - Function**

| Author | Outcome | LOE | N | Duration | Results (%) |
|---|---|---|---|---|---|
| Wallace, et al. 2004 | Stiffness – none | IV | 140 | 2.9 years | 55% |
| Wallace, et al. 2004 | Stiffness – mild | IV | 140 | 2.9 years | 41% |
| Wallace, et al. 2004 | Stiffness – moderate | IV | 140 | 2.9 years | 3% |
| Wallace, et al. 2004 | Stiffness – severe | IV | 140 | 2.9 years | 1% |

**Table 32. Functional Bracing - Strength**

| Author | Outcome | LOE | N | Duration | Results (%) |
|---|---|---|---|---|---|
| Wallace, et al. 2004 | Weakness – none | IV | 140 | 2.9 years | 56% |
| Wallace, et al. 2004 | Weakness - mild | IV | 140 | 2.9 years | 33% |
| Wallace, et al. 2004 | Weakness - moderate | IV | 140 | 2.9 years | 10% |
| Wallace, et al. 2004 | Weakness -severe | IV | 140 | 2.9 years | 1% |

**Table 33. Functional Bracing - Return to Work and Sports**

| Author | Outcome | LOE | N | Duration | Results (%) |
|---|---|---|---|---|---|
| Wallace, et al. 2004 | Return to Full Preinjury Level of Employment | IV | 122 | 2.9 years | 98% |
| Wallace, et al. 2004 | Return to Sports - same or better level | IV | 101 | 2.9 years | 37% |
| Wallace, et al. 2004 | Return to Sports - diminished or none | IV | 101 | 2.9 years | 63% |
| McComis, et al. 1997 | Return to Sports - same level | V | 15 | 26 weeks | 67% |
| McComis, et al. 1997 | Return to Sports - diminished | V | 15 | 26 weeks | 33% |

**Table 34. Functional Bracing - Return to Work and Sports (days)**

| Author | Outcome | LOE | N | Results (mean) |
|---|---|---|---|---|
| Wallace, et al. 2004 | Time to Return to Work | IV | 122 | 7 days (max: 52 days) |
| McComis, et al. 1997 | Time to Return to Work | V | 15 | 4 days (max: 3 weeks) |
| Wallace, et al. 2004 | Time to Return to Sports | IV | 101 | 8 weeks (range 2 weeks - 6 months) |

**Table 35. Functional Bracing - Complications**

| Author | Outcome | LOE | N | Duration | Cast (%) | Cast + orthosis (%) | Results |
|---|---|---|---|---|---|---|---|
| Neumayer, et al. 2009 | Pulmonary embolism | IV | 57 | 12 months | n/a | 2% | n/a |
| Wallace, et al. 2004 | DVT | IV | 140 | 2.9 years (0.4-8.2) | n/a | 1% | n/a |
| Wallace, et al. 2004 | Temporary Drop foot | IV | 140 | 2.9 years (0.4-8.2) | n/a | 1% | n/a |

n/a: not applicable

**Table 36. Functional Bracing - Rerupture**

| Author | Outcome | LOE | N | Duration | Cast (%) | Cast + orthosis (%) | Results |
|---|---|---|---|---|---|---|---|
| Neumayer, et al. 2009 | Complete rerupture | IV | 57 | 12 months | n/a | 9% | n/a |
| Wallace, et al. 2004 | Complete rerupture | IV | 140 | 2.9 years (0.4-8.2) | n/a | 2% | n/a |
| Neumayer, et al. 2009 | Partial rerupture | IV | 57 | 12 months | n/a | 4% | n/a |
| Wallace, et al. 2004 | Partial rerupture | IV | 140 | 2.9 years (0.4-8.2) | n/a | 4% | n/a |

n/a: not applicable

**EXCLUDED ARTICLES**

**Table 37. Functional Bracing - Excluded Studies**

| Author | Title | Exclusion Reason |
|---|---|---|
| Edna TH; | Non-operative treatment of Achilles tendon ruptures | case series cast only |
| Fruensgaard S, et al. | Conservative treatment for acute rupture of the Achilles tendon | casting only |
| Hufner TM, et al. | Long-term results after functional non-operative treatment of Achilles tendon rupture | cast only case series |
| Inglis AE, et al. | Ruptures of the tendo achillis. An objective assessment of surgical and non-surgical treatment | Less than 10 patients per arm |
| Josey RA, et al. | Immediate, full weight bearing cast treatment of acute Achilles tendon ruptures: a long-term follow-up study | cast only case series |
| Keller J, et al | Closed treatment of Achilles tendon rupture | case series cast only |

| Author | Title | Exclusion Reason |
|---|---|---|
| Lea RB; Smith L; | Non-surgical treatment of tendo achillis rupture | casting only |
| Lildholdt T, et al | Conservative treatment to Achilles tendon rupture. A follow-up study of 14 cases | cast only case series |
| Nistor L; | Conservative treatment of fresh subcutaneous rupture of the Achilles tendon | casting only case series |
| Pendleton H, et al. | Residual functional problems after non-operative treatment of Achilles tendon rupture | cast only case series |
| Persson A, et al. | The treatment of total ruptures of the Achilles tendon by plaster immobilisation | cast only case series |
| Roberts CP, et al | Dynamised cast management of Achilles tendon ruptures | retrospective case series |

**STUDY QUALITY**

**Table 38. Study Quality - Randomized Control Trials**

| ● = Yes ○ = No<br>× = Not Reported | | | | | Stochastic Randomization | Allocation Concealment | Patients Blinded | Those rating outcome Blinded | Follow Up - 80% or more | All groups have similar outcome performance at entry |
|---|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome** | **N** | **Treatment(s)** | **Level of Evidence** | | | | | | |
| Saleh, et al. 1992 | Rerupture | 31 | Cast vs. Cast + Orthosis | Level II | × | × | ○ | ○ | ● | ● |

**Table 39. Study Quality - Non-Randomized Comparative Study**

| ● = Yes ○ = No<br>× = Not Reported | | | | | Completion rate - less than 20% difference between groups | All groups concurrently treated | All groups receive same treatment | All groups evaluated using same outcome measures | All groups have approximately equal follow-up times | Follow Up - 80% or more | Same center for experimental and control group data | Similar performance on outcome at baseline | Patient characteristics comparable at baseline |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome** | **N** | **Treatment(s)** | **Level of Evidence** | | | | | | | | | |
| Ingvar, et al. 2005 | Re-rupture | 194 | Cast vs. Cast + Orthosis | Level IV | × | ○ | ● | ● | × | ● | ● | ● | × |

**Table 40. Study Quality - Case Series**

| ● = Yes ○ = No<br>× = Not Reported | | | | | Consecutive enrollment of patients | Follow Up - 80% or more | All patients evaluated using same outcome measures | All patients receive same treatment | All patients have approximately equal follow-up times |
|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome** | **N** | **Treatment(s)** | **Level of Evidence** | | | | | |
| Neumayer, et al. 2009 | Satisfaction (VAS) | 46 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Wallace, et al. 2004 | Satisfaction | 140 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Wallace, et al. 2004 | Pain | 140 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Wallace, et al. 2004 | Stiffness | 140 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Wallace, et al. 2004 | Weakness | 140 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Wallace, et al. 2004 | Return to Full Preinjury Level of Employment | 122 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Wallace, et al. 2004 | Return to Sports - same or better level | 101 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Wallace, et al. 2004 | Return to Sports - diminished or none | 101 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| McComis, et al. 1997 | Return to Sports - same level | 15 | Cast + Orthosis | Level V | ● | ○ | ● | ● | ● |
| McComis, et al. 1997 | Return to Sports - diminished | 15 | Cast + Orthosis | Level V | ● | ○ | ● | ● | ● |
| Wallace, et al. 2004 | Time to Return to Work | 122 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| McComis, et al. 1997 | Time to Return to Work | 15 | Cast + Orthosis | Level V | ● | ○ | ● | ● | ● |
| Wallace, et al. 2004 | Time to Return to Sports | 140 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Neumayer, et al. 2009 | Complete re-rupture | 57 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |

| ● = Yes ○ = No<br>× = Not Reported | | | | | Consecutive enrollment of patients | Follow Up - 80% or more | All patients evaluated using same outcome measures | All patients receive same treatment | All patients have approximately equal follow-up times |
|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome** | **N** | **Treatment(s)** | **Level of Evidence** | | | | | |
| Wallace, et al. 2004 | Complete re-rupture | 140 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Neumayer, et al. 2009 | Partial rerupture | 57 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Wallace, et al. 2004 | Partial rerupture | 140 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Neumayer, et al. 2009 | Pulmonary embolism | 57 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Wallace, et al. 2004 | DVT | 140 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |
| Wallace, et al. 2004 | Temporary Drop foot | 140 | Cast + Orthosis | Level IV | ● | ● | ● | ● | ● |

## RECOMMENDATION 5

Operative treatment is an option in patients with acute Achilles tendon rupture.

AAOS Strength of Recommendation: **Weak**

**Rationale:**

To answer this recommendation, we reviewed studies addressing the efficacy of operative treatment. A systematic review of the literature included eight studies[20, 19, 27, 28, 29, 30,31, 32]that addressed the efficacy of open repair and six studies[33, 29, 34, 21, 27, 31,] addressing the efficacy of minimally invasive techniques. This systematic review addressed only the efficacy of operative treatment and therefore did not consider the comparisons made in the studies. Please refer to Recommendation 3 and its rationale for a comparison of non-operative and operative treatment of acute Achilles tendon ruptures. In addition, relevant comparative information about operative techniques can be found in Recommendation 8 and its rationale.

A systematic review of the literature included eight studies[20, 19, 27, 28, 29, 30,31, 32] that addressed the efficacy of open repair and six studies[33, 29, 34, 21, 27, 31] addressing the efficacy of minimally invasive techniques. By six months the return to activity ranged from 73% to 100% after operative treatment (see Table 42 through Table 58). After twelve months, 92% of patients reported they had no pain (see Table 48).

All studies relevant to this Recommendation were Level IV (see Table 60) because this is non comparative data.

**Supporting Evidence:**

To determine the efficacy of open repair and/or minimally invasive repair we need a study with preoperative and postoperative data. However, the data we identified only provides postoperative measures and is therefore unreliable. We have tabled the postoperative data from eight studies[20, 19, 27, 28, 29, 30,31,32] that address efficacy of open repair and six studies [33, 29, 34, 21, 27, 31] that address minimally invasive techniques. Table 42 through Table 58 demonstrate the wide variety of patient-oriented outcome measures and duration to follow-up used to evaluate patients receiving operative treatment for Achilles tendon rupture. The inconsistency of these outcome measures makes comparisons between studies difficult. Because the body of evidence is weak, it does not allow for additional statistical analysis.

Please see Recommendation 7 for results of operative treatment comparisons.

## SUMMARY OF EVIDENCE

### Table 41. Open Repair – All Outcomes

| Outcome | Result (Efficacy) |
|---|---|
| Time until Return to Work | ? |
| Time until Return to Stair Climbing | ? |
| Time until Return to Walking | ? |
| Time until Return to Sports | ? |
| Return to work (%) | ? |
| Return to ADL (%) | ? |
| Return to Final Functional Activities (%) | ? |
| Pain (%) | ? |
| Function- Abnormal ankle movement (%) | ? |
| Abnormal Run (%) | ? |
| Abnormal toe stand (%) | ? |
| Satisfaction (%) | ? |

### Table 42. Open Repair - Return to work

| Author | LOE | N | Outcome | Mean time Mean (SD) |
|---|---|---|---|---|
| Moller, et al. 2001 | IV | 59 | Return to work (days) | 54.9 (nr) |
| Cetti, et al. 1993 | IV | 56 | Return to work (weeks) | 6.2 (SD 2.15) |
| Moller, et al. 2001 | IV | 59 | Return to heavy work (days) | 102.2 (nr) |
| Moller, et al. 2001 | IV | 59 | Return to sedentary work (days) | 30.8 (nr) |
| Moller, et al. 2001 | IV | 59 | Return to light, mobile work (days) | 35.7 (nr) |

nr: not reported

**Table 43. Open Repair - Activities of daily living**

| Author | LOE | N | Outcome | Mean time Mean (SD)/(range) |
|---|---|---|---|---|
| Bhattacharyya, et al. 2009 | IV | 53 | Return to Normal Stair Climbing (weeks) | 19 (3.5)‡ |
| Bhattacharyya, et al. 2009 | IV | 53 | Return to Normal Walking (weeks) | 17 (3)‡ |
| Uchiyama, et al. 2007 | IV | 84 | Return to same level of sports (months) (high level athletes) | 5 (17-26 weeks) |
| Uchiyama, et al. 2007 | IV | 84 | Return to jogging (weeks) | 12.3 (range 8-21) |

‡AAOS Calculation

**Table 44. Open Repair- Mean time until return to athletic activity**

| Author | LOE | N | Outcome | Mean time Mean (range) |
|---|---|---|---|---|
| Uchiyama, et al. 2007 | IV | 84 | Return to same level of sports (months) (high level athletes) | 5 (17-26 weeks) |
| Uchiyama, et al. 2007 | IV | 84 | Return to jogging (weeks) | 12.3 (8-21) |

**Table 45. Open Repair- Percent of patients able to return to activities of daily living**

| Author | LOE | N | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|
| Lim, et al. 2001 | IV | 33 | Return to ADL | 2 months | 6% |
| Lim, et al. 2001 | IV | 33 | Return to ADL | 3 months | 85% |
| Lim, et al. 2001 | IV | 33 | Return to ADL | 6 months | 100% |
| Lim, et al. 2001 | IV | 33 | Return to final functional activity‡ | 3 months | 36% |
| Lim, et al. 2001 | IV | 33 | Return to final functional activity‡ | 6 months | 64% |

‡ Final functional activity defined as "patient is unhindered in all his or her activities apart from active sports"

**Table 46. Open Repair- Percent of patients able to return to work**

| Author | LOE | N | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|
| Moller, et al. 2001 | IV | 59 | Return to work (days) | nr | 100% |
| Moller, et al. 2001 | IV | 59 | Return to sedentary work (days) | nr | 22% |
| Moller, et al. 2001 | IV | 59 | Return to light, mobile work (days) | nr | 54% |
| Moller, et al. 2001 | IV | 59 | Return to heavy work (days) | nr | 24% |

Nr: not reported

**Table 47. Open Repair- Percent of patients able to return to sports**

| Author | LOE | N | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|
| Coutts, et al 2002 | IV | 22 | Return to pre-injury sporting level | nr | 91% |
| Moller, et al. 2001 | IV | 47 | Return to sports - same level | 12 months | 54% |
| Cetti, et al. 1993 | IV | 52 | Return to sports - same level | 12 months | 62% |
| Lim, et al. 2001 | IV | 33 | Return to active sporting/outdoor activities | 3 months | 9% |
| Lim, et al. 2001 | IV | 33 | Return to active sporting/outdoor activities | 6 months | 48% |
| Moller, et al. 2001 | IV | 47 | Return to sports - stopped | 12 months | 16% |

| Author | LOE | N | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|
| Cetti, et al. 1993 | IV | 52 | Return to sports - stopped | 12 months | 15% |
| Cetti, et al. 1993 | IV | 52 | Return to sports - diminished level | 12 months | 23% |

**Table 48: Open Repair- Percent of patients with pain**

| Author | LOE | N | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|
| Aktas, et al. 2007 | IV | 30 | Pain - Mild w/ maximal exertion | 6 months | 14% |
| Aktas, et al. 2007 | IV | 30 | Pain - Absent | 6 months | 86% |
| Moller, et al. 2001 | IV | 52 | Pain-during walking | 12 months | 2% |
| Moller, et al. 2001 | IV | 52 | Pain-moderate | 12 months | 6% |
| Moller, et al. 2001 | IV | 52 | Pain-none | 12 months | 92% |
| Aktas, et al. 2009 | IV | 23 | Pain- mild during exertion | 22 months | 13% |

**Table 49. Open Repair- Percent of patients able to complete functional activities**

| Author | LOE | N | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|
| Cetti, et al. 1993 | IV | 56 | Function-Abnormal ankle movement | 4 months | 52% |
| Cetti, et al. 1993 | IV | 56 | Function-Abnormal ankle movement | 12 months | 18% |
| Cetti, et al. 1993 | IV | 56 | Function-Abnormal gait | 4 months | 27% |
| Cetti, et al. 1993 | IV | 56 | Function-Abnormal gait | 12 months | 5% |
| Cetti, et al. 1993 | IV | 56 | Function-Abnormal run | 4 months | 52% |
| Cetti, et al. 1993 | IV | 56 | Function-Abnormal run | 12 months | 13% |
| Cetti, et al. 1993 | IV | 56 | Function-Abnormal toe stand | 4 months | 21% |
| Cetti, et al. 1993 | IV | 56 | Function-Abnormal toe stand | 12 months | 9% |

**Table 50. Open Repair- Percent of patients with excellent satisfaction**

| Author | LOE | N | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|
| Lim, et al. 2001 | IV | 33 | Satisfaction - Excellent | 6 months | 42% |

**Table 51. Minimally Invasive Repair- All outcomes**

| Outcome | Result (Efficacy) |
|---|---|
| Return to Work (%) | ? |
| Return to Stair Climbing (%) | ? |
| Return to Walking (%) | ? |
| Return to Sports (%) | ? |
| Return to work (%) | ? |
| Return to ADL (%) | ? |
| Return to Final Functional Activities (%) | ? |
| Satisfaction (%) | ? |
| Function- Abnormal ankle movement (%) | ? |
| Return to same level of activity (%) | ? |
| Able to walk without limitations (%) | ? |
| Return to sports (%) | ? |
| Pain (%) | ? |

**Table 52. Minimally Invasive Repair- Percent of Patients able to return to activity**

| Author | LOE | N | Treatment | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|---|
| ES Ng, et al. 2007 | IV | 25 | percutaneous | Return to activity - same level | 65.5 months | 96% |
| Lim, et al. 2001 | IV | 33 | percutaneous | Return to ADL | 2 months | 6% |
| Lim, et al. 2001 | IV | 33 | percutaneous | Return to ADL | 3 months | 76% |
| Lim, et al. 2001 | IV | 33 | percutaneous | Return to ADL | 6 months | 100% |
| Lim, et al. 2001 | IV | 33 | percutaneous | Return to final functional activity | 3 months | 27% |
| Lim, et al. 2001 | IV | 33 | percutaneous | Return to final functional activity | 6 months | 73% |
| Chillemi, et al. 2002 | IV | 38 | percutaneous | Able to walk without limitation | 6 months | 100% |

**Table 53. Minimally Invasive Repair - Percent of patients able to return to sports**

| Author | LOE | N | Treatment | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|---|
| Lim, et al. 2001 | IV | 33 | percutaneous | Return to active sporting/outdoor activities | 3 months | 0% |
| Lim, et al. 2001 | IV | 33 | percutaneous | Return to active sporting/outdoor activities | 6 months | 67% |
| Chillemi, et al. 2002 | IV | 14 | percutaneous | Return to sports activity (frequent participant 2-3 times per week) | nr | 57% |

nr: not reported

**Table 54. Minimally Invasive Repair - Satisfaction**

| Author | LOE | Treatment | N | Outcome | Follow-up | % |
|---|---|---|---|---|---|---|
| Lim, et al. 2001 | IV | percutaneous | 33 | Satisfaction - Excellent | 6 months | 52% |

**Table 55. Minimally Invasive Repair - Mean time until return to activity**

| Author | LOE | Treatment | N | Outcome | Mean Time (Days) Mean (SD) |
|---|---|---|---|---|---|
| Metz, et al. 2008 | IV | minimally-invasive | 40 | Return to work | 59 (82) |
| Bhattacharyya, et al. 2009 | IV | minimally-invasive | 53 | Return to Normal Walking (weeks) | 12.5 (3)‡ |
| Bhattacharyya, et al. 2009 | IV | minimally-invasive | 53 | Return to Normal Stair Climbing (weeks) | 14 (3)‡ |

‡= AAOS Calculation

**Table 56. Minimally Invasive Repair-Percent of patients able to return to sports**

| Author | LOE | Treatment | N | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|---|
| Metz, et al. 2008 | IV | minimally-invasive | 36 | Return to sports | 12 months | 67% |
| Metz, et al. 2008 | IV | minimally-invasive | 36 | Change sports | 12 months | 11% |
| Metz, et al. 2008 | IV | minimally-invasive | 36 | Stop sports | 12 months | 22% |
| Metz, et al. 2008 | IV | minimally-invasive | 40 | Return to work | nr | 98% |

nr: not reported

**Table 57. Minimally Invasive Repair-Percent of patients able to return to work**

| Author | LOE | Treatment | N | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|---|
| Metz, et al. 2008 | IV | minimally-invasive | 40 | Return to work | nr | 98% |

nr: not reported

**Table 58. Minimally Invasive Repair-Pain**

| Author | LOE | Treatment | N | Outcome | Follow-up | % of Patients |
|---|---|---|---|---|---|---|
| Aktas, et al.2009 | IV | minimally-invasive | 23 | Percent of patient with mild pain during exertion | 22 months | 4.5% |

## EXCLUDED ARTICLES

**Table 59. Excluded Articles**

| Author | Title | Exclusion Reason |
|---|---|---|
| Leppilahti J;Forsman K;Puranen J;Orava S; | Outcome and prognostic factors of Achilles rupture repair using a new scoring method | Not best available evidence |
| Chiodo CP;Wilson MG; | Current concepts review: acute ruptures of the Achilles tendon | Not best available evidence |
| Weber M;Niemann M;Lanz R;Muller T; | Nonoperative treatment of acute rupture of the Achilles tendon: results of a new protocol and comparison with operative treatment | Retrospective |
| Maffulli N;Tallon C;Wong J;Lim KP;Bleakney R; | Early weightbearing and ankle mobilization after open repair of acute midsubstance tears of the Achilles tendon | Not Relevant |
| Halasi T;Tallay A;Berkes I; | Percutaneous Achilles tendon repair with and without endoscopic control | Retrospective |
| Costa ML;Shepstone L;Darrah C;Marshall T;Donell ST; | Immediate full-weight bearing mobilisation for repaired Achilles tendon ruptures: a pilot study | Not best available evidence |
| Maffulli N;Tallon C;Wong J;Peng LK;Bleakney R; | No adverse effect of early weight bearing following open repair of acute tears of the Achilles tendon | Not relevant-looks at effect of weight bearing following surgery |
| van der Linden-van der Zwaag HM;Nelissen RG;Sintenie JB; | Results of surgical versus non-surgical treatment of Achilles tendon rupture | Not best available evidence |

| Author | Title | Exclusion Reason |
|---|---|---|
| Steele GJ;Harter RA;Ting AJ; | Comparison of functional ability following percutaneous and open surgical repairs of acutely ruptured Achilles tendons | No patient-oriented outcome |
| Cretnik A;Kosanovic M;Smrkolj V; | Percutaneous versus open repair of the ruptured Achilles tendon: a comparative study | Not best available evidence |
| Goren D;Ayalon M;Nyska M; | Isokinetic strength and endurance after percutaneous and open surgical repair of Achilles tendon ruptures | No patient - oriented outcome |
| Wagnon R;Akayi M; | The Webb-Bannister percutaneous technique for acute Achilles' tendon ruptures: a functional and MRI assessment | Not best available evidence |
| Mortensen HM;Skov O;Jensen PE; | Early motion of the ankle after operative treatment of a rupture of the Achilles tendon. A prospective, randomized clinical and radiographic study | Not best available evidence |
| Hufner TM;Brandes DB;Thermann H;Richter M;Knobloch K;Krettek C; | Long-term results after functional nonoperative treatment of Achilles tendon rupture | Not best available evidence |
| Kauranen K;Kangas J;Leppilahti J; | Recovering motor performance of the foot after Achilles rupture repair: a randomized clinical study about early functional treatment vs. early immobilization of Achilles tendon in tension | No patient oriented outcome |
| Majewski M;Rohrbach M;Czaja S;Ochsner P; | Avoiding sural nerve injuries during percutaneous Achilles tendon repair | Not best available evidence |
| Attinger CE;Ducic I;Hess CL;Basil A;Abbruzzesse M;Cooper P; | Outcome of skin graft versus flap surgery in the salvage of the exposed Achilles tendon in diabetics versus nondiabetics | Not relevant |
| Kotnis R;David S;Handley R;Willett K;Ostlere S; | Dynamic ultrasound as a selection tool for reducing Achilles tendon re-ruptures | Combines open and percutaneous repair |
| Schonberger TJ;Janzing HM;Morrenhof JW;de Visser AC;Muitjens P; | Operative treatment of acute Achilles tendon rupture: Open end-to-end-reconstruction versus reconstruction with Mitek-anchors | Retrospective case series |
| Metz R;Verleisdonk EJ;van der Heijden GJ;Clevers GJ;Hammacher ER;Verhofstad MH;van der WC; | Acute Achilles tendon rupture: minimally invasive surgery versus nonoperative treatment with immediate full weightbearing--a randomized controlled trial | Not Relevant |
| Suchak AA;Bostick GP;Beaupre LA;Durand DC;Jomha NM; | The influence of early weight bearing compared with non-weight bearing after surgical repair of the Achilles tendon | All patients do not receive same treatment |

| Author | Title | Exclusion Reason |
|---|---|---|
| Blankstein A;Israeli A;Dudkiewicz I;Chechik A;Ganel A; | Percutaneous Achilles tendon repair combined with real-time sonography | No patient oriented outcome |
| Maffulli N;Longo UG;Ronga M;Khanna A;Denaro V; | Favorable Outcome of Percutaneous Repair of Achilles Tendon Ruptures in the Elderly | Not best available evidence |
| Twaddle BC;Poon P; | Early motion for Achilles tendon ruptures: is surgery important? A randomized, prospective study | No relevant outcomes |
| Fujikawa A;Kyoto Y;Kawaguchi M;Naoi Y;Ukegawa Y; | Achilles tendon after percutaneous surgical repair: serial MRI observation of uncomplicated healing | No patient oriented outcome |
| Costa ML;MacMillan K;Halliday D;Chester R;Shepstone L;Robinson AH;Donell ST; | Randomised controlled trials of immediate weight bearing mobilisation for rupture of the tendo Achillis | Not Relevant |
| Carter TR;Fowler PJ;Blokker C; | Functional postoperative treatment of Achilles tendon repair | Retrospective |
| Perez TA; | Traumatic rupture of the Achilles Tendon. Reconstruction by transplant and graft using the lateral peroneus brevis | Insufficient Quantitative Data |
| Martinelli B; | Percutaneous repair of the Achilles tendon in athletes | Not best available evidence |
| Gorschewsky O;Pitzl M;Putz A;Klakow A;Neumann W; | Percutaneous repair of acute Achilles tendon rupture | Insufficient Quantitative Data |
| Mullaney MJ;McHugh MP;Tyler TF;Nicholas SJ;Lee SJ; | Weakness in end-range plantar flexion after Achilles tendon repair | No patient oriented outcome |
| Rumian AP;Molloy S;Solan M;Newman KJ;Elliott D; | Surgical repair of the Achilles tendon: The lateral approach | Not best available evidence |
| Ebinesan AD;Sarai BS;Walley GD;Maffulli N; | Conservative, open or percutaneous repair for acute rupture of the Achilles tendon | Retrospective comparative |
| Chan SK;Chung SC;Ho YF; | Minimally invasive repair of ruptured Achilles tendon | Retrospective |
| Lildholdt T;Munch-Jorgensen T; | Conservative treatment to Achilles tendon rupture. A follow-up study of 14 cases | No description of surgery |

| Author | Title | Exclusion Reason |
|---|---|---|
| Nistor L; | Surgical and non-surgical treatment of Achilles Tendon rupture. A prospective randomized study | Not best available evidence |
| Haggmark T;Liedberg H;Eriksson E;Wredmark T; | Calf muscle atrophy and muscle function after non-operative vs operative treatment of Achilles tendon ruptures | No patient oriented outcome |
| Kangas J;Pajala A;Siira P;Hamalainen M;Leppilahti J; | Early functional treatment versus early immobilization in tension of the musculotendinous unit after Achilles rupture repair: a prospective, randomized, clinical study | Not Relevant |
| Synder M;Zwierzchowski H; | Post-operative results in fresh injuries the Achilles tendon | Insufficient Quantitative Data |
| Therbo M;Petersen MM;Nielsen PK;Lund B; | Loss of bone mineral of the hip and proximal tibia following rupture of the Achilles tendon | No patient oriented outcome |
| Solveborn SA;Moberg A; | Immediate free ankle motion after surgical repair of acute Achilles tendon ruptures | Surgeons did not follow same technique |
| Kakiuchi M; | A combined open and percutaneous technique for repair of tendo Achillis. Comparison with open repair | Not best available evidence |
| Buchgraber A;Passler HH; | Percutaneous repair of Achilles tendon rupture. Immobilization versus functional postoperative treatment | No baseline data |
| Speck M;Klaue K; | Early full weightbearing and functional treatment after surgical repair of acute Achilles tendon rupture | No baseline data |
| Aoki M;Ogiwara N;Ohta T;Nabeta Y; | Early active motion and weightbearing after cross-stitch Achilles tendon repair | Insufficient Data |
| Dargel J;Ninck J;Koebke J;Appell HJ;Pennig D;Hillekamp J; | Influence of knee flexion on plantarflexion moments after open or percutaneous Achilles tendon repair | Retrospective comparative |
| Follak N;Ganzer D;Merk H; | The utility of gait analysis in the rehabilitation of patients after surgical treatment of Achilles tendon rupture | No relevant patient oriented outcomes |
| Horstmann T;Lukas C;Mayer F;Winter E;Ambacher T;Heitkamp H;Dickhuth H; | Isokinetic strength and strength endurance of the lower limb musculature ten years after Achilles tendon repair | All patients did not receive exact surgery |
| Kerkhoffs GM;Struijs PA;Raaymakers EL;Marti RK; | Functional treatment after surgical repair of acute Achilles tendon rupture: wrap vs walking cast | Not Relevant |

| Author | Title | Exclusion Reason |
|---|---|---|
| Soldatis JJ;Goodfellow DB;Wilber JH; | End-to-end operative repair of Achilles tendon rupture | Retrospective |
| Cetti R; | Ruptured Achilles tendon--preliminary results of a new treatment | No baseline data |
| Cetti R;Henriksen LO;Jacobsen KS; | A new treatment of ruptured Achilles tendons. A prospective randomized study | Not Relevant |

**STUDY QUALITY**

Table 60. Study Quality

| ● = Yes ○ = No<br>× = Not Reported | | | | | Consecutive Enrollment | Follow up <80% | Same Outcomes | Same Treatments | Equal Follow up Time |
|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome Measure** | **N** | **Treatment** | **LoE** | | | | | |
| Aktas, et al. 2007 | Pain - Mild w/ maximal exertion‡ | 30 | Open Repair | IV | ● | ● | ● | ● | ● |
| Aktas, et al. 2007 | Pain - Absent‡ | 30 | Open Repair | IV | ● | ● | ● | ● | ● |
| Bhattacharyya, et al. 2009 | Return to Normal Walking (weeks) | 53 | Open Repair | IV | ● | ● | ● | ● | ● |
| Bhattacharyya, et al. 2009 | Return to Normal Stair Climbing (weeks) | 53 | Open Repair | IV | ● | ● | ● | ● | ● |
| Bhattacharyya, et al. 2009 | Return to Normal Walking (weeks) | 53 | Minimally Invasive Repair | IV | ● | ● | ● | ● | ● |
| Bhattacharyya, et al. 2009 | Return to Normal Stair Climbing (weeks) | 53 | Minimally Invasive Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Return to work (weeks) | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Return to sports - diminished level | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Return to sports - same level | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Return to sports - stopped | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Function-Abnormal ankle movement | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Function-Abnormal ankle movement | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Function-Abnormal gait | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Function-Abnormal gait | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Function-Abnormal run | 56 | Open Repair | IV | ● | ● | ● | ● | ● |

| ● = Yes ○ = No<br>× = Not Reported | | | | | Consecutive Enrollment | Follow up <80% | Same Outcomes | Same Treatments | Equal Follow up Time |
|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome Measure** | **N** | **Treatment** | **LoE** | | | | | |
| Cetti, et al. 1993 | Function-Abnormal run | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Function-Abnormal toe stand | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Cetti, et al. 1993 | Function-Abnormal toe stand | 56 | Open Repair | IV | ● | ● | ● | ● | ● |
| Chillemi, et al. 2002 | Able to walk without limitation | 38 | Percutaneous Repair | IV | ● | ● | ● | ● | ● |
| Chillemi, et al. 2002 | Return to sports activity (frequent participant 2-3 times per week) | 14 | Percutaneous Repair | IV | ● | ● | ● | ● | ● |
| Coutts, et al 2002 | Return to pre-injury sporting level | 22 | Open Repair | IV | ○ | ● | ● | ● | ● |
| ES Ng, et al. 2007 | Return to activity - same level | 25 | Percutaneous Repair | IV | ● | ● | ● | ● | ● |
| Gigante, et al. 2008 | SF-12 - Physical Component Score | 19 | Percutaneous Repair | IV | ● | ● | ● | ● | ● |
| Gigante, et al. 2008 | SF-12 - Mental Component Score | 19 | Percutaneous Repair | IV | ● | ● | ● | ● | ● |
| Lim, et al. 2001 | Return to active sporting/outdoor activities | 33 | Open Repair | IV | ● | ● | ● | ● | ● |
| Lim, et al. 2001 | Return to active sporting/outdoor activities | 33 | Percutaneous Repair | IV | ● | ● | ● | ● | ● |
| Lim, et al. 2001 | Return to ADL | 33 | Open Repair | IV | ● | ● | ● | ● | ● |
| Lim, et al. 2001 | Return to final functional activity | 33 | Open Repair | IV | ● | ● | ● | ● | ● |
| Lim, et al. 2001 | Satisfaction - Excellent | 33 | Open Repair | IV | ● | ● | ● | ● | ● |
| Lim, et al. 2001 | Return to final functional activity | 33 | Percutaneous Repair | IV | ● | ● | ● | ● | ● |

| ● = Yes ○ = No<br>× = Not Reported | | | | | Consecutive Enrollment | Follow up <80% | Same Outcomes | Same Treatments | Equal Follow up Time |
|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome Measure** | **N** | **Treatment** | **LoE** | | | | | |
| Lim, et al. 2001 | Return to active sporting/outdoor activities | 33 | Percutaneous Repair | IV | ● | ● | ● | ● | ● |
| Lim, et al. 2001 | Return to active sporting/outdoor activities | 33 | Percutaneous Repair | IV | ● | ● | ● | ● | ● |
| Lim, et al. 2001 | Satisfaction - Excellent | 33 | Percutaneous Repair | IV | ● | ● | ● | ● | ● |
| Metz, et al. 2008 | Return to work | 40 | Minimally Invasive Repair | IV | ● | ● | ● | ● | ● |
| Metz, et al. 2008 | Return to sports | 40 | Minimally Invasive Repair | IV | ● | ● | ● | ● | ● |
| Metz, et al. 2008 | Change sports | 40 | Minimally Invasive Repair | IV | ● | ● | ● | ● | ● |
| Metz, et al. 2008 | Stop sports | 40 | Minimally Invasive Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Return to sedentary work (days) | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Return to light, mobile work (days) | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Return to work (days) | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Return to heavy work (days) | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Return to sports - same level | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Return to sports - stopped | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Return to sedentary work (days) | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Return to light, mobile work (days) | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Return to work (days) | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Return to heavy work (days) | 59 | Open Repair | IV | ● | ● | ● | ● | ● |

| ● = Yes ○ = No<br>× = Not Reported | | | | | Consecutive Enrollment | Follow up <80% | Same Outcomes | Same Treatments | Equal Follow up Time |
|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome Measure** | **N** | **Treatment** | **LoE** | | | | | |
| Moller, et al. 2001 | Pain-during walking | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Pain-moderate | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Moller, et al. 2001 | Pain-none | 59 | Open Repair | IV | ● | ● | ● | ● | ● |
| Uchiyama, et al. 2007 | Return to jogging (weeks) | 84 | Open Repair | IV | ○ | ● | ● | ● | ● |
| Uchiyama, et al. 2007 | Return to same level of sports (months) (high level athletes) | 84 | Open Repair | IV | ○ | ● | ● | ● | ● |
| Aktas, et al.Aktas, et al.2009 | Pain | 46 | Minimally Invasive Repair | IV | ● | ● | ● | ● | ● |
| Aktas, et al.Aktas, et al.2009 | Pain | 46 | Open Repair | IV | ● | ● | ● | ● | ● |

## RECOMMENDATION 6

In the absence of reliable evidence, it is the opinion of the work group that although operative treatment is an option , it should be approached more cautiously in patients with diabetes, neuropathy, immunocompromised states, age above 65, tobacco use, sedentary lifestyle, obesity (BMI >30), peripheral vascular disease or local/systemic dermatologic disorders.

AAOS Strength of Recommendation: **Consensus**

**Rationale:**

Rupture of the Achilles tendon occurs not only in healthy active individuals, but also in those with substantial medical histories. We were unable to find any published studies that addressed the effects of co-morbid conditions on the success of operative repair. Therefore, this recommendation is based on expert opinion, and is consistent with current clinical practice.

The consensus of the work group is that consideration of non-operative treatment should occur before performing operative repair of Achilles tendon ruptures in those individuals with conditions that may impair wound healing. These individuals may be at increased risk for wound problems and infection with subsequent detrimental effect on outcome.

**Supporting Evidence:**

We did not identify any studies to address this recommendation.

## RECOMMENDATION 7

For patients who will be treated operatively for an acute Achilles tendon rupture, we are unable to recommend for or against preoperative immobilization or restricted weight bearing.

AAOS Strength of Recommendation: **Inconclusive**

**Rationale:**

We were unable to find any published studies that addressed the effects of preoperative immobilization or restricted weight bearing on the success of operative repair of acute rupture of this tendon.

**Supporting Evidence:**

We did not identify any studies to address this recommendation.

## RECOMMENDATION 8

Open, limited open and percutaneous techniques are options for treating patients with acute Achilles tendon rupture.

AAOS Strength of Recommendation: **Weak**

**Rationale:**

We defined the following operative repairs:

> Open – procedure utilizing an extended incision for exposure allowing visualization of the rupture and tendon to allow direct placement of sutures for the repair.
> Limited-Open – procedure utilizing a small incision for exposure allowing direct visualization of the ruptured ends.
> Percutaneous – procedure without direct exposure of the tendon rupture site.

A systematic review identified three level II comparative trials[29, 33, 35] investigating percutaneous repair and one level II and two level III comparative trials studying limited-open repairs.[27, 36, 31] In both these comparisons, there was no significant difference in reruptures between open and minimally invasive techniques.

Two studies [29, 33] that compared percutaneous to open repairs found no statistically significant difference in return to activity. Two studies[27, 36] comparing limited open to open repair found that patients treated with a limited open technique returned to activity sooner than those treated with an open repair.

There is no statistically significant difference in satisfaction in patients treated with percutaneous or open repairs.[29] Patients treated with limited open repair techniques have statistically significantly fewer symptoms than those treated with open technique but no statistically significant differences in pain.

One study[33] showed a statistically significant difference in the short term in favor of the percutaneous group for wound breakdown/delayed healing. Two studies[29, 33] showed statistically significantly less scar adhesion in the percutaneous repair group compared with the open repair. Similarly, patients treated with limited open groups had statistically significantly fewer minor surgical site infections leading to delayed wound healing and in one study fewer severe wound infections.[27]

Beyond short term wound complications, there is no identified added benefit when comparing long term adverse events between open repair and minimally invasive repair. While in some studies[33, 31] there were an increased number of superficial infections in the open repair group, there was no statistically significant difference between groups for deep infections[31]. One study[29] reported a statistically significant difference in superficial infections between the open group and percutaneous groups, however, the authors[29] did

not administer IV antibiotics to the open control group. Based on these considerations, we downgraded this body of evidence to weak.

The literature reviewed refers primarily to non insertional ruptures in which there is sufficient distal tendon for repair. It is acknowledged that a small subset of ACTR consist of purely insertional injuries, often with a segment of bone attached. The latter group is beyond the scope of this GL. However, the reader should be aware of the fact that the repair techniques reviewed may not be compatible with these distal ruptures.

Consideration should also be given to the location of the tear when performing a repair in a percutaneous or limited-open fashion. Tears located at the proximal or distal ends of the tendon may compromise the ability to successfully complete a limited open repair. The orthopaedic surgeon performing the repair may need to extend the incision, converting it to an open technique if unable to obtain good suture fixation with a limited-open or percutaneous technique.

**Supporting Evidence:**

We examined studies that made two different comparisons. Two level II studies compared percutaneous repair to open repair.[29, 35] Two level II studies and two level III studies compared limited open to open repair.[31,33 27, 36]

**PERCUTANEOUS VS OPEN REPAIR**

Patients treated with percutaneous repair scored significantly higher on the SF-12 physical and mental component scores (see Table 61). There was no significant difference in the amount of patients who returned to functional activities, activities of daily living, (see Table 62) or patient satisfaction (see Table 63). The amount of reruptures did not significantly differ between treatment groups (see Table 65)

Studies[29, 33] reported no significant difference in the number of sural nerve injuries, superficial infection with staphalococcus, hypertonic scars, or keloid formation (Table 64). Patients treated with percutaneous repair had significantly less wound breakdown/delay of healing as well as less scar adhesions (see Table 64). No significant difference in the amount of deep infections was reported. One study[29] reported a statistically significant difference in superficial infection, while another study[33] did not report a difference(see Table 64). However, the study which did report more superficial infections in the open repair group, did not administer IV antibiotics. Wound puckering occurred significantly more in patients treated with percutaneous repair (see Table 64).

**SUMMARY OF EVIDENCE- PERCUTANEOUS VS. OPEN**

**Table 61. Percutaneous and Limited Open vs. Open - Global Outcomes**

| Author | Outcome | LOE | N | Duration |
|---|---|---|---|---|
| | | | | 24 months |
| Gigante | SF-12 - Physical Component Score | II | 39 | ● P |

| Author | Outcome | LOE | N | Duration |
|---|---|---|---|---|
| | | | | 24 months |
| Gigante | SF-12 - Mental Component Score | II | 39 | ● P |

● P: Statistically Significant in Favor of Percutaneous Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance

**Table 62. Percutaneous vs. Open - Return to Activities and Function**

| Author | Outcome | LOE | N | Duration (months) | |
|---|---|---|---|---|---|
| | % | | | 6 | 65.5 |
| ES Ng | Return to Activity | II | 68 | | ○ |
| Lim | Return to Activities of Daily Living | II | 66 | ○ | |
| Lim | Returned to Final Functional Activity‡ | II | 66 | ○ | |

● P: Statistically Significant in Favor of Percutaneous Repair
● L: Statistically Significant in Favor of Limited Open Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance
‡ Final Functional Activity: "When patient was unhindered in all his or her activities apart from sports."

**Table 63. Percutaneous vs. Open - Satisfaction**

| Author | Outcome | LOE | N | Duration |
|---|---|---|---|---|
| | % | | | 6 months |
| Lim | Satisfaction | II | 66 | ○ |

● P: Statistically Significant in Favor of Percutaneous Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance

**Table 64. Percutaneous vs. Open- Complications**

| Author | Adverse Event | LOE | N | Duration (months) | |
|---|---|---|---|---|---|
| | | | | 6 | 65.5 |
| Ng | Wound breakdown/ delay healing | II | 68 | | ●P |
| Ng | Sural Nerve Injury | II | 68 | | ○ |
| Lim | Sural Nerve Problems | II | 66 | ○ | |
| Lim | Deep Infection with | II | 66 | ○ | |

| Author | Adverse Event | LOE | N | Duration (months) | |
|---|---|---|---|---|---|
| | | | | 6 | 65.5 |
| | staphalococcus | | | | |
| Lim | Adhesions | II | 66 | ●P | |
| Ng | Scar Adhesion | II | 68 | | ●P |
| Ng | Superficial Infection | II | 68 | | ○ |
| Lim | Superficial Infection | II | 66 | ●P | |
| Lim | Superficial Infection with staphalococcus | | | ○ | |
| Ng | Hypertrophic Scar | II | 68 | | ○ |
| Lim | Keloid Formation | II | 66 | ○ | |
| Lim | Wound Puckering | II | 66 | ● Op | |

● P: Statistically Significant in Favor of Percutaneous Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance

**Table 65. Percutaneous vs. Open- Rerupture**

| Author | Adverse Event | LOE | N | Duration (months) | |
|---|---|---|---|---|---|
| | | | | 6 | 65.5 |
| Lim et al 2001 | Rerupture | II | 66 | ○ | |
| Ng, et al 2006 | Rerupture | II | 68 | | ○ |

● P: Statistically Significant in Favor of Percutaneous Repair
● L: Statistically Significant in Favor of Limited Open Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance

**LIMITED OPEN VS OPEN REPAIR**

Patients treated with limited open repair did not have less pain or score higher on the AOFAS scale than patients treated with open repair (see Table 66 and Table 67). Patients treated with limited open repair returned to normal walking, stair climbing, and sports in significantly less time than patients treated with standard open repair (seeTable 68). A significantly larger percentage of patients treated with limited open repair had fewer symptoms compared to patients treated with open repair (seeTable 69).

There was no significant difference in the number of reruptures between treatment groups (see Table 71). There was no statistically significant difference in DVT, large hematoma, stiffness of ankle, insertional tendinopathy, or deep infection between the open and limited repair groups (see Table 70). However, patients treated with limited open repair had significantly fewer severe wound infections, superficial infections, and minor surgical site infections than patients treated with open repair (see Table 70).

## SUMMARY OF EVIDENCE- LIMITED OPEN VS. OPEN

### Table 66. Minimally Invasive vs. Open- Pain

| Author | Outcome | LOE | N | Duration |
|---|---|---|---|---|
| | % | | | 6 months |
| Aktas | Pain | II | 46 | ○ |

● P: Statistically Significant in Favor of Percutaneous Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance

### Table 67. Minimally Invasive vs. Open- Global Outcomes

| Author | Outcome | LOE | N | Duration |
|---|---|---|---|---|
| | | | | 24 months |
| Aktas | AOFAS | II | 40 | ○ |

● P: Statistically Significant in Favor of Percutaneous Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance

### Table 68. Limited Open vs. Open- Return to Activity

| Author | Outcome | LOE | N | Duration | |
|---|---|---|---|---|---|
| | (weeks) | | | 12 months | 63.5 months |
| Bhattacharyya | Return to Normal Walking | III | 53 | ●Mini | |
| Bhattacharyya | Return to Normal Stair Climbing | III | 53 | ●Mini | |
| Kakiuchi | Return to Sports | III | 22 | | ● Mini |

● Mini: Statistically Significant in Favor of Minimally Invasive (mini-open) Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance

### Table 69. Mini-Open vs. Open- Symptoms

| Author | Outcome | LOE | N | Duration |
|---|---|---|---|---|
| | (%) | | | 63.5 months |
| Kakiuchi | Symptoms | III | 22 | ● Mini |

● Mini: Statistically Significant in Favor of Minimally Invasive Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance

**Table 70. Limited Open Repair vs. Open - Complications**

| Author | Complication | LOE | N | Duration | |
|---|---|---|---|---|---|
| | | | | 6 Months | 12 months |
| Bhattacharyya | Minor Surgical Site Infection with Delayed Wound Healing | III | 53 | | ● Mini |
| Bhattacharyya | Severe Wound Infection and Dehiscence | III | 53 | | ● Mini |
| Aktas, 2009 | Deep Infection | II | 40 | ○ | |
| Aktas, 2009 | Superficial Infection | II | 40 | ● Mini | |
| Aktas, 2009 | Insertional Tendinopathy | II | 40 | ○ | |
| Aktas, 2009 | Stiffness of the ankle | II | 40 | ○ | |
| Aktas, 2009 | Large Hematoma | II | 40 | ○ | |
| Aktas, 2009 | DVT | II | 40 | ○ | |

● P: Statistically Significant in Favor of Percutaneous Repair
● L: Statistically Significant in Favor of Limited Open Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance

**Table 71. Mini-Open vs. Open – Rerupture**

| Author | Adverse Events | LOE | N | Duration |
|---|---|---|---|---|
| | | | | 63.5 months |
| Kakiuchi | Rerupture | III | 22 | ○ |

● P: Statistically Significant in Favor of Percutaneous Repair
● L: Statistically Significant in Favor of Limited Open Repair
● Op: Statistically Significant in Favor of Open Repair
○ No statistical significance

## EXCLUDED ARTICLES

### Table 72. Excluded Studies - All Operative Techniques

| Author | Title | Exclusion Reason |
|---|---|---|
| Cretnik A, et al | Percutaneous versus open repair of the ruptured Achilles tendon. a comparative study | Not best available evidence |
| Wagnon R, et al | The Webb-Bannister percutaneous technique for acute Achilles' tendon ruptures. a functional and MRI assessment | Not best available evidence |
| Assal M, et al | Limited open repair of Achilles tendon ruptures. a technique with a new instrument and findings of a prospective multicenter study | Not best available evidence - not comparative |
| Halasi T, et al | Percutaneous Achilles tendon repair with and without endoscopic control | Not best available evidence - not comparative |
| Cretnik A, et al | Percutaneous suturing of the ruptured Achilles tendon under local anesthesia | Not best available evidence - not comparative |
| Coutts A, et al | Clinical and functional results of open operative repair for Achilles tendon rupture in a non-specialist surgical unit | Not best available evidence - not comparative |
| Calder JD, et al | Independent evaluation of a recently described Achilles tendon repair technique | Not best available evidence - not comparative |
| Uchiyama E, et al | A modified operation for Achilles tendon ruptures | Not best available evidence - not comparative |
| Maes R, et al; | Is percutaneous repair of the Achilles tendon a safe technique? A study of 124 cases | Not best available evidence - not comparative |
| Amlang MH, et al | The percutaneous suture of the Achilles tendon with the Dresden instrument | Not best available evidence - not comparative |
| Tang KL, et al | Arthroscopically assisted percutaneous repair of fresh closed Achilles tendon rupture by Kessler's suture | Not best available evidence - not comparative |
| Fortis AP, et al | Repair of Achilles tendon rupture under endoscopic control | Not best available evidence - not comparative |
| Schonberger TJ, et al | Operative treatment of acute Achilles tendon rupture. Open end-to-end-reconstruction versus reconstruction with Mitek-anchors | Retrospective case series |
| Hohendorff B, et al | Long-term results after operatively treated Achilles tendon rupture. fibrin glue versus suture | suture technique |
| Kuwada GT; | Critical analysis of tendo Achillis repair using Achilles tendon rupture classification system and repair | Not best available evidence - not comparative |

| Author | Title | Exclusion Reason |
|---|---|---|
| Lansdaal JR, et al | The results of 163 Achilles tendon ruptures treated by a minimally invasive surgical technique and functional after treatment | Not best available evidence - not comparative |
| Blankstein A, et al | Percutaneous Achilles tendon repair combined with real-time sonography | Not best available evidence - not comparative |
| Majewski M, et al | Avoiding sural nerve injuries during percutaneous Achilles tendon repair | Not best available evidence - not comparative |
| Jung HG, et al | Outcome of Achilles tendon ruptures treated by a limited open technique | Not best available evidence - not comparative |
| Scarfi G, et al | Percutaneous repair of Achilles tendon | Not best available evidence - not comparative |
| Crnica S, et al | Follow-up results of Achilles tendon rupture treatment by the method of modified percutaneous suture | Not best available evidence - not comparative |
| Perez TA; | Traumatic rupture of the Achilles Tendon. Reconstruction by transplant and graft using the lateral peroneus brevis | Not best available evidence - not comparative |
| Ma GW;Griffith TG; | Percutaneous repair of acute closed ruptured Achilles tendon. a new technique | Not best available evidence - not comparative |
| Boyden EM, et al; | Late versus early repair of Achilles tendon rupture. Clinical and biomechanical evaluation | Not best available evidence - not comparative |
| Soldatis JJ, et al | End-to-end operative repair of Achilles tendon rupture | Not best available evidence - not comparative |
| Martinelli B; | Percutaneous repair of the Achilles tendon in athletes | Not best available evidence - not comparative |
| Mellor SJ;Patterson MH; | Tendo Achillis rupture; surgical repair is a safe option | Not best available evidence - not comparative |
| Bruggeman NB, et al | Wound complications after open Achilles tendon repair. an analysis of risk factors | Not best available evidence - not comparative |
| Webb JM;Bannister GC; | Percutaneous repair of the ruptured tendo Achillis | Not best available evidence - not comparative |
| Gillespie HS;George EA; | Results of surgical repair of spontaneous rupture of the Achilles tendon | Not best available evidence - not comparative |
| Jessing P;Hansen E; | Surgical treatment of 102 tendo achillis ruptures-- suture or tenontoplasty? | Not best available evidence - not comparative |

| Author | Title | Exclusion Reason |
|---|---|---|
| Kiviluoto O, et al | Surgical repair of subcutaneous rupture of the Achilles tendon | Not best available evidence - not comparative |
| Haggmark T, et al | Calf muscle atrophy and muscle function after non-operative vs. operative treatment of Achilles tendon ruptures | Not best available evidence - not comparative |
| Bomler J;Sturup J; | Achilles tendon rupture. An 8-year follow up | Not best available evidence - not comparative |
| Hogsaa B, et al | Surgical treatment of Achilles tendon ruptures | Not best available evidence - not comparative |
| FitzGibbons RE, et al | Percutaneous Achilles tendon repair | Not best available evidence - not comparative |
| Chillemi C, et al | Percutaneous repair of Achilles tendon rupture. Ultrasonographical and isokinetic evaluation | Not best available evidence - not comparative |
| Gorschewsky O, et al | Percutaneous repair of acute Achilles tendon rupture | Not best available evidence - not comparative |

**STUDY QUALITY**

**Table 73. Study Quality - RCTs**

| ● = Yes ○ = No × = Not Reported | | | | | Stochastic Randomization | Allocation Concealment | Patients Blinded | Those rating outcome Blinded | Follow Up - 80% or more | All groups have similar outcome performance at entry |
|---|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome** | **N** | **Treatment(s)** | **Level of Evidence** | | | | | | |
| Gigante, et al. 2008 | SF-12. Physical Component | 39 | Open Repair vs. Percutaneous Repair | Level II | ● | × | × | ● | ● | × |
| Gigante, et al. 2008 | SF-12. Mental Component | 39 | Open Repair vs. Percutaneous Repair | Level II | ● | × | × | ● | ● | × |
| Lim, et al. 2001 | Complications | 66 | Open Repair vs. Percutaneous Repair | Level II | ○ | ● | ● | × | ● | × |
| Lim, et al. | Duration of Immobilization | 66 | Open Repair vs. | Level II | ○ | ● | ● | × | ● | × |

| ● = Yes ○ = No<br>× = Not Reported | | | | | Stochastic Randomization | Allocation Concealment | Patients Blinded | Those rating outcome Blinded | Follow Up - 80% or more | All groups have similar outcome performance at entry |
|---|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome** | **N** | **Treatment(s)** | **Level of Evidence** | | | | | | |
| 2001 | | | Percutaneous Repair | | | | | | | |
| Lim, et al. 2001 | Return to activities of daily living | 66 | Open Repair vs. Percutaneous Repair | Level II | ○ | ● | ● | × | ● | × |
| Lim, et al. 2001 | Return to functional activity | 66 | Open Repair vs. Percutaneous Repair | Level II | ○ | ● | ● | × | ● | × |
| Aktas, et al. 2009 | AOFAS | 40 | Minimally Invasive vs. Open | Level II | × | × | × | ○ | ● | ● |

**Table 74. Quality of Studies - Comparative Studies**

| ● = Yes ○ = No<br>× = Not Reported | | | | | All groups have similar characteristics at entry | All groups have similar outcome performance at entry | All groups concurrently treated | Follow Up - 80% or more | Same center for experimental and control group data |
|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome** | **N** | **Treatment(s)** | **Level of Evidence** | | | | | |
| Kakiuchi, et al. 1995 | Return to Sports | 22 | Percutaneous and Minimally Invasive vs. Open Repair | Level III | × | × | ● | ○ | ● |
| Kakiuchi, et al. 1995 | Symptoms - None | 22 | Percutaneous and Minimally Invasive vs. Open Repair | Level III | × | × | ● | ○ | ● |
| Kakiuchi, et al. 1995 | Symptoms - Stiffness | 22 | Percutaneous and Minimally Invasive vs. Open Repair | Level III | × | × | ● | ○ | ● |
| Kakiuchi, et al. 1995 | Symptoms - Discomfort | 22 | Percutaneous and Minimally Invasive vs. Open Repair | Level III | × | × | ● | ○ | ● |
| Kakiuchi, et al. 1995 | Symptoms - Pain | 22 | Percutaneous and Minimally Invasive vs. Open Repair | Level III | × | × | ● | ○ | ● |
| Kakiuchi, et al. 1995 | Re-rupture | 22 | Percutaneous and Minimally Invasive vs. Open Repair | Level III | × | × | ● | ○ | ● |
| Ng, et al. 2006 | Return to Activity - Same Level | 68 | Percutaneous vs. Open Repair | Level II | ● | × | ● | ● | ● |
| Ng, et al. 2006 | Complications | 68 | Percutaneous vs. Open Repair | Level II | ● | × | ● | ● | ● |
| Bhattacharyya, et al. 2009 | Return to Normal Walking | 53 | Minimally Invasive vs. Open Repair | Level III | ○ | × | ● | ● | ● |
| Bhattacharyya, et al. 2009 | Return to Normal Stair Climbing | 53 | Minimally Invasive vs. Open Repair | Level III | ○ | × | ● | ● | ● |
| Bhattacharyya, et al. 2009 | Severe Wound Infection and | 53 | Minimally Invasive vs. Open Repair | Level III | ○ | × | ● | ● | ● |

| ● = Yes ○ = No<br>× = Not Reported | | | | | All groups have similar characteristics at entry | All groups have similar outcome performance at entry | All groups concurrently treated | Follow Up - 80% or more | Same center for experimental and control group data |
|---|---|---|---|---|---|---|---|---|---|
| **Author** | **Outcome** | **N** | **Treatment(s)** | **Level of Evidence** | | | | | |
| | Dehiscence | | | | | | | | |
| Bhattacharyya, et al. 2009 | Minor Surgical Site Infection | 53 | Minimally Invasive vs. Open Repair | Level III | ○ | × | ● | ● | ● |
| Bhattacharyya, et al. 2009 | Delayed Wound Healing | 53 | Minimally Invasive vs. Open Repair | Level III | ○ | × | ● | ● | ● |

**STUDY RESULTS**

**Table 75. Limited open vs. Open - Global Outcomes**

| Author | Outcome | LOE | N | Duration | Minimally Invasive | Open | Results |
|---|---|---|---|---|---|---|---|
| | | | | | mean (SD) | mean (SD) | |
| Gigante, et al. 2008 | SF-12 - Physical Component Score | II | 39 | 24 months | 52.6 (2.31) | 50.7 (2.57) | p = 0.02‡ |
| | SF-12- Mental Component Score | II | 39 | 24 months | 52.2 (1.91) | 50.4 (2.75) | p = 0.02‡ |

‡ AAOS calculation

**Table 76. Percutaneous vs. Open - Return to Activities**

| Author | Outcome | LOE | N | Duration | Percutaneous (%) | Open (%) | Results |
|---|---|---|---|---|---|---|---|
| Lim, et al. 2001 | Return to Activities of Daily Living | II | 66 | 6 months | 100% | 100% | NS |
| Lim, et al. 2001 | Returned to Final Functional Activity | II | 66 | 6 months | 100% | 100% | NS |

NS: not significant; authors do not report p-value

**Table 77. Percutaneous vs. Open - Satisfaction**

| Author | Outcome | LOE | N | Duration | Percutaneous (%) | Open (%) | Results |
|---|---|---|---|---|---|---|---|
| Lim, et al. 2001 | Satisfaction - Excellent | II | 66 | 6 months | 52% | 42% | NS |

NS: not significant; authors do not report p-value

**Table 78. Percutaneous vs. Open - Complications**

| Author | Complications | LOE | N | Duration | Percutaneous (%) | Open (%) | Results |
|---|---|---|---|---|---|---|---|
| Lim, et al 2001 | Re-rupture | II | 66 | 6 months | 3% | 6% | p = .55‡ |
| Lim, et al. 2001 | Sural Nerve Problems | II | 66 | 6 months | 3% | 0% | p = .15‡ |
| Lim, et al. 2001 | Deep infection with wound breakdown and staphalococcus infection | II | 66 | 6 months | 0% | 3% | p = 0.155‡ |
| Lim, et al. 2001 | Superficial Infection with staphalococcus infection | II | 66 | 6 months | 0% | 3% | p = 0.155‡ |