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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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## 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 (roentgenograms, 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 ( $\leq 2$  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.*

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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).<sup>1</sup> Studies of European communities report comparable values ranging from 6 to 18 ruptures per 100,000 people.<sup>1-4</sup>

## **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.<sup>5</sup>

## **ETIOLOGY**

Most acute Achilles tendon ruptures are traumatic in origin. Some studies have shown that ruptured Achilles tendons have occult degeneration.<sup>3</sup>

## **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.<sup>1</sup>

## **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.<sup>3</sup> 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.<sup>6,7</sup> 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 of 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  $\geq 10$  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.”<sup>8</sup> 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.<sup>9</sup> Radiographic results are an example of a surrogate outcome.

We only included data for an outcome if  $\geq 50\%$  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  $\leq 80\%$  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<sup>10</sup> as well as others.<sup>11</sup>

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<sup>10</sup> 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**

<b>Strength</b>	<b>Overall Quality of Evidence</b>	<b>Description of Evidence</b>
<b>Strong</b>	Good Quality Evidence	Level I evidence from more than one study with consistent findings for recommending for or against the intervention or diagnostic.
<b>Moderate</b>	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.
<b>Weak</b>	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 or against the intervention or diagnostic.
<b>Inconclusive</b>	No Evidence or Conflicting Evidence	The evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention or diagnostic.
<b>Consensus</b>	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**

<b>Guideline Language</b>	<b>Strength of Recommendation</b>
<i>We recommend</i>	Strong
<i>We suggest</i>	Moderate
Is an <i>option</i>	Weak
We are <i>unable to recommend for or against</i>	Inconclusive
In the absence of reliable evidence, it is the <i>opinion</i> 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.<sup>12</sup> 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.<sup>13</sup> 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 ( $p < 0.05$ ).<sup>14</sup>

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.<sup>15</sup>

## **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 Orthopaedic 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<sup>16</sup> 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.<sup>16</sup>

### **SUMMARY OF EVIDENCE**

The study<sup>16</sup> 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**

<b>Author</b>	<b>Title</b>	<b>Exclusion Reason</b>
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**

<p>● = Yes ○ = No X = Not Reported n/a = not applicable</p>				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 (roentgenograms, 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<sup>16, 17</sup> 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.<sup>16, 17</sup> 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 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**

<b>Author</b>	<b>N</b>	<b>Test</b>	<b>Sensitivity (95% CI)</b>	<b>Specificity (95% CI)</b>
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.<sup>18-21</sup> 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.<sup>18-21</sup>

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.<sup>22, 22</sup>

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.<sup>23-25</sup>

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.<sup>26 22</sup> 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.<sup>23-25</sup>

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 rerupture 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 (%)**

<b>Author</b>	<b>Outcome</b>	<b>LOE</b>	<b>N</b>	<b>Duration</b>	<b>Results (%)</b>
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**

<b>Author</b>	<b>Outcome</b>	<b>LOE</b>	<b>N</b>	<b>Duration</b>	<b>Results (%)</b>
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**

<b>Author</b>	<b>Outcome</b>	<b>LOE</b>	<b>N</b>	<b>Duration</b>	<b>Results (%)</b>
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**

<p>● = Yes ○ = No × = Not Reported</p>					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**

<p>● = Yes ○ = No × = Not Reported</p>					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**

<p>● = Yes ○ = No × = Not Reported</p>					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	●	●	●	●	●

<p style="text-align: center;">● = Yes   ○ = No × = Not Reported</p>					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<sup>20, 19, 27, 28, 29, 30,31, 32</sup> that addressed the efficacy of open repair and six studies<sup>33, 29, 34, 21, 27, 31,</sup> 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<sup>20, 19, 27, 28, 29, 30,31, 32</sup> that addressed the efficacy of open repair and six studies<sup>33, 29, 34, 21, 27, 31</sup> 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<sup>20, 19, 27, 28, 29, 30,31,32</sup> that address efficacy of open repair and six studies<sup>33, 29, 34, 21, 27, 31</sup> 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**

<b>Outcome</b>	<b>Result (Efficacy)</b>
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**

<b>Author</b>	<b>LOE</b>	<b>N</b>	<b>Outcome</b>	<b>Mean time Mean (SD)</b>
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**

<b>Author</b>	<b>LOE</b>	<b>N</b>	<b>Outcome</b>	<b>Mean time Mean (SD)/(range)</b>
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**

<b>Author</b>	<b>LOE</b>	<b>N</b>	<b>Outcome</b>	<b>Mean time Mean (range)</b>
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



<b>Author</b>	<b>Title</b>	<b>Exclusion Reason</b>
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

<b>Author</b>	<b>Title</b>	<b>Exclusion Reason</b>
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

<b>Author</b>	<b>Title</b>	<b>Exclusion Reason</b>
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

<b>Author</b>	<b>Title</b>	<b>Exclusion Reason</b>
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 × = 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 × = 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 × = 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 × = 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<sup>29, 33, 35</sup> investigating percutaneous repair and one level II and two level III comparative trials studying limited-open repairs.<sup>27, 36, 31</sup> In both these comparisons, there was no significant difference in reruptures between open and minimally invasive techniques.

Two studies<sup>29, 33</sup> that compared percutaneous to open repairs found no statistically significant difference in return to activity. Two studies<sup>27, 36</sup> 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.<sup>29</sup> 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<sup>33</sup> showed a statistically significant difference in the short term in favor of the percutaneous group for wound breakdown/delayed healing. Two studies<sup>29, 33</sup> 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.<sup>27</sup>

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<sup>33, 31</sup> there were an increased number of superficial infections in the open repair group, there was no statistically significant difference between groups for deep infections<sup>31</sup>. One study<sup>29</sup> reported a statistically significant difference in superficial infections between the open group and percutaneous groups, however, the authors<sup>29</sup> 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.<sup>29, 35</sup> Two level II studies and two level III studies compared limited open to open repair.<sup>31,33 27, 36</sup>

**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<sup>29, 33</sup> 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<sup>29</sup> reported a statistically significant difference in superficial infection, while another study<sup>33</sup> 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 (see Table 68). A significantly larger percentage of patients treated with limited open repair had fewer symptoms compared to patients treated with open repair (see Table 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

<b>Author</b>	<b>Title</b>	<b>Exclusion Reason</b>
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 tenoplasty?	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

<p>● = Yes ○ = No × = Not Reported</p>					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	○	●	●	×	●	×

<p style="text-align: center;">● = Yes   ○ = No × = Not Reported</p>					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**

<p>● = Yes ○ = No × = Not Reported</p>					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	○	×	●	●	●

<p style="text-align: center;">● = Yes ○ = No × = Not Reported</p>					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‡









































































































































































































































































































