AAOS
American Academy of Orthopaedic Surgeons

The Diagnosis and Treatment of Osteochondritis Dissecans

Evidence-Based Clinical Practice Guideline

Adopted by:
The American Academy of Orthopaedic Surgeons Board of Directors
December 1, 2023

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Disclaimer

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

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

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

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2023 REPORT FOR THE UPDATE OF THE 2010 CLINICAL PRACTICE GUIDELINE ON THE DIAGNOSIS AND TREATMENT OF OSTEOCHONDRITIS DISSECANS

This guideline is greater than 5 years old and is reviewed every five years. New studies have been published since this guideline was developed, however the AAOS has determined that these studies are not sufficient to warrant changing the guideline scope at this time. Due to the paucity of evidence and the relevance of the existing scope, this guideline was approved to be updated via the AAOS Rapid Update Methodology. The 2023 additions to this document are outlined below and reflect additions based on newly available evidence relevant to the original PICO questions and resulting guideline recommendations. Only the recommendations have been updated, and all other information (e.g., the methods, work group roster, recommendation rationales) remain that of the original 2010 guideline. Per AAOS Clinical Practice Guideline Rapid Update Methodology, inconclusive recommendations are not revisited. The inconclusive recommendations found in the 2010 guideline have been moved to Appendix XIV. For the full AAOS Clinical Practice Guidelines Rapid Update Methodology please visit: aaos.org/quality

OVERVIEW OF 2023 UPDATES TO THE 2010 ORIGINAL GUIDELINE

1. Updated the strength of recommendation of the following recommendations based on new evidence:
    a. MRI OCD Knee (upgraded from Limited to High).
    b. Option of Surgery for Skeletally Immature Patients with Salvageable Unstable OCD Lesions (upgraded from Consensus to Limited)
    c. Option of Surgery for Skeletally Mature Patients with Salvageable Unstable OCD Lesions (upgraded from Consensus to Limited)

2. Addition of the following supporting evidence (quality assessment tables can be found in Appendix XV):

    a. Ackermann, J., Mestriner, A. B., Shah, N., Gomoll, A. H. Effect of Autogenous Bone Marrow Aspirate Treatment on Magnetic Resonance Imaging Integration of Osteochondral Allografts in the Knee: A Matched Comparative Imaging Analysis. *Arthroscopy* 2019; 8: 2436-2444

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Summary of Recommendations

Inconclusive recommendations published in 2010 have not been updated and can be found in their original form in Appendix XIV.

The following is a summary of the recommendations in the AAOS' clinical practice guideline, The Diagnosis and Treatment of Osteochondritis Dissecans (OCD) of the Knee. The scope of this guideline is specifically limited to Osteochondritis Dissecans of the Knee. 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 a patient with knee symptoms (pain, swelling, locking, catching, popping, giving way) and/or signs (tenderness, effusion, loss of motion, crepitus), x-rays (including AP, lateral, sunrise/Merchant, and tunnel views) are an option.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

2. In a patient with a known OCD lesion on x-ray, an MRI of the knee is an option to characterize the OCD lesion or when concomitant knee pathology is suspected such as meniscal pathology, ACL injury, or articular cartilage injury.

Strength of Recommendation: High ★★★★

Description: Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention.

3. **Symptomatic** skeletally immature patients with unstable or displaced OCD lesions be offered the option of surgery.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

4. **Symptomatic** skeletally mature patients with unstable or displaced OCD lesions be offered the option of surgery.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

5. In the absence of reliable evidence, it is the opinion of the work group that patients who remain symptomatic after treatment for OCD have a history and physical examination, x-rays and/or MRI to assess healing.

Strength of Recommendation: Consensus ★☆☆☆

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

6. In the absence of reliable evidence, it is the opinion of the work group that patients who have received surgical treatment of OCD be offered post-operative physical therapy.

   Strength of Recommendation: Consensus ★☆☆☆

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

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I. INTRODUCTION

OVERVIEW

This clinical practice guideline is based on a systematic review of published studies on the diagnosis and treatment of osteochondritis dissecans (OCD) of the knee. 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 evaluating patients for osteochondritis dissecans of the knee. 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. This clinical practice guideline was developed following a systematic review of the available literature regarding the diagnosis and treatment of osteochondritis dissecans of the knee. The systematic review detailed herein was conducted between May 2009 and March 2010 and demonstrates where there is good evidence, where evidence is lacking, and what topics future research must target in order to improve the diagnosis and treatment of osteochondritis dissecans of the knee. 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. Providers unfamiliar with the treatment of patients with OCD should be referred to qualified physicians and surgeons.We created this guideline as an educational tool to guide qualified physicians through a series of diagnostic 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. Treatments and procedures applicable to the individual patient rely on mutual communication between patient, physician and other healthcare practitioners.

INTENDED USERS

This guideline is intended to be used by orthopaedic surgeons and all qualified clinicians managing patients with osteochondritis dissecans (OCD) of the knee. Typically, orthopaedic surgeons will have completed medical training, a qualified residency in orthopaedic surgery, and some may have completed additional sub-specialty training.

The guideline is intended to both guide clinical practice and to serve as an information resource for medical practitioners. An extensive literature base was considered during the

Disclaimer

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Summary of Recommendations

Inconclusive recommendations published in 2010 have not been updated and can be found in their original form in Appendix XIV.

The following is a summary of the recommendations in the AAOS' clinical practice guideline, The Diagnosis and Treatment of Osteochondritis Dissecans (OCD) of the Knee. The scope of this guideline is specifically limited to Osteochondritis Dissecans of the Knee. 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 a patient with knee symptoms (pain, swelling, locking, catching, popping, giving way) and/or signs (tenderness, effusion, loss of motion, crepitus), x-rays (including AP, lateral, sunrise/Merchant, and tunnel views) are an option.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

2. In a patient with a known OCD lesion on x-ray, an MRI of the knee is an option to characterize the OCD lesion or when concomitant knee pathology is suspected such as meniscal pathology, ACL injury, or articular cartilage injury.

Strength of Recommendation: High ★★★★

Description: Evidence from two or more "High" quality studies with consistent findings for recommending for or against the intervention.

3. **Symptomatic** skeletally immature patients with unstable or displaced OCD lesions be offered the option of surgery.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

4. **Symptomatic** skeletally mature patients with unstable or displaced OCD lesions be offered the option of surgery.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more "Low" quality studies with consistent findings or evidence from a single "Moderate" quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

5. In the absence of reliable evidence, it is the opinion of the work group that patients who remain symptomatic after treatment for OCD have a history and physical examination, x-rays and/or MRI to assess healing.

Strength of Recommendation: Consensus ★☆☆☆

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

6. In the absence of reliable evidence, it is the opinion of the work group that patients who have received surgical treatment of OCD be offered post-operative physical therapy.

   Strength of Recommendation: Consensus ★☆☆☆

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

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I. INTRODUCTION

OVERVIEW

This clinical practice guideline is based on a systematic review of published studies on the diagnosis and treatment of osteochondritis dissecans (OCD) of the knee. 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 evaluating patients for osteochondritis dissecans of the knee. 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. This clinical practice guideline was developed following a systematic review of the available literature regarding the diagnosis and treatment of osteochondritis dissecans of the knee. The systematic review detailed herein was conducted between May 2009 and March 2010 and demonstrates where there is good evidence, where evidence is lacking, and what topics future research must target in order to improve the diagnosis and treatment of osteochondritis dissecans of the knee. 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. Providers unfamiliar with the treatment of patients with OCD should be referred to qualified physicians and surgeons.We created this guideline as an educational tool to guide qualified physicians through a series of diagnostic 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. Treatments and procedures applicable to the individual patient rely on mutual communication between patient, physician and other healthcare practitioners.

INTENDED USERS

This guideline is intended to be used by orthopaedic surgeons and all qualified clinicians managing patients with osteochondritis dissecans (OCD) of the knee. Typically, orthopaedic surgeons will have completed medical training, a qualified residency in orthopaedic surgery, and some may have completed additional sub-specialty training.

The guideline is intended to both guide clinical practice and to serve as an information resource for medical practitioners. An extensive literature base was considered during the

development of this guideline. In general, practicing clinicians do not have the resources necessary for such a large project. The AAOS hopes that this guideline will assist practitioners not only in making clinical decisions about their patients, but also in describing, to patients and others, why the chosen treatment represents the best available course of action.

This guideline is not intended for use as a benefits determination document. Making these determinations involves many factors not considered in the present document, including available resources, business and ethical considerations, and need.

Users of this guideline may also want to consider any appropriate use criteria (AUC) that the AAOS has developed on the topic of this guideline. The focus of AAOS guidelines is on the question "Does it work?" When an AAOS guideline or an AAOS-endorsed guideline shows effectiveness, the AAOS may undertake development of AUC that ask the question "In whom does it work?" This dichotomy is necessary because the medical literature (both orthopaedic and otherwise) typically does not adequately address the latter question.

That having been said, evidence for the effectiveness of medical services is not always present. This is true throughout all areas of medicine. Accordingly, all users of this clinical practice guideline are cautioned that an absence of evidence is not evidence of ineffectiveness. An absence means just that; there are no data. It is the AAOS position that rigorously developed clinical practice guidelines should not seek to guide clinical practice when data are absent unless the disease, disorder, or condition in question can result in loss of life or limb. The AAOS incorporates expert opinion into a guideline under these circumstances, and only under these circumstances. Accordingly, when the AAOS states that it cannot recommend for or against a given intervention or service, it is stating that currently available data do not provide clear guidance on which course of action is best, and that it is therefore reluctant to make a recommendation that has potentially national ramifications. Although true in all circumstances, the AAOS believes that when evidence is absent, it is particularly important for the treatment for osteochondritis dissecans (OCD) of the knee to be based on mutual patient and physician communication, with discussion of available treatments and procedures applicable to that patient, and with consideration of the natural history of the disease and current practice patterns. 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 skeletally immature and skeletally mature patients with osteochondritis dissecans of the knee.

ETIOLOGY

The etiology of Osteochondritis Dissecans of the knee is unknown. Family history, growth disorders, ischemia, trauma and repetitive microtrauma due to high levels of participation in sports in juveniles have been theorized as possible etiologic factors of Osteochondritis Dissecans of the Knee.[1-12]

INCIDENCE

The exact incidence of Osteochondritis Dissecans of the knee is unknown due to a variety of classification systems, studies with small numbers of patients and inconsistencies within the literature regarding the diagnosis, treatment, and prognosis of patients with the disease. One study[2] reported the incidence as 29 per 100,000 in males and 18 per 100,000 in females between 1965-1974. This study reported males were at higher risk than females but a later study reported the incidence of females is increasing. Both authors theorize that the increase in the incidence can be related to an increase in sports activities.

One study[1] reported that the mean age of JOCD has decreased from 12.9 years (1983) to 11.3 years (1992) in children. This study[1] also suggests that the incidence of JOCD is due to children being introduced to sports at an earlier age and "cumulative exercise is increasing annually due to the demands of competition." Adults typically experience vague, chronic or non-specific knee pain.[12, 13]

BURDEN OF DISEASE

The burden of disease from juvenile and adult Osteochondritis Dissecans is not known. Individuals affected by OCD limit activity and decrease sports participation to limit pain.[14]

RISK FACTORS

Osteochondritis dissecans can occur in different joints, including the knee, elbow, hip and ankle.[15] The knee is most commonly affected. Risk factors are theorized to include repetitive stress to the joint, trauma or joint injuries, age between 10 and 20 years and participation in sports.[15-17]

POTENTIAL BENEFITS AND HARMS

The aim of treatment is pain relief, improved knee function, and potentially altering the degenerative joint process. Surgical treatments are associated with some known risks such as infection, bleeding, venous thromboembolic events and persistent pain, although arthroscopic approaches have relatively low risk compared to more invasive surgeries.[18] Also, some surgical treatments cannot be performed arthroscopically; many require arthroscopic evaluation followed by open reduction and internal fixation of the fragment with bone grafting. Non operative treatment also presents with challenges because "it is difficult to predict which stable juvenile Osteochondritis Dissecans lesions will heal and the patient and family, at the advice of the treating physician, may wait to see if non-operative treatment allows the lesions to heal."[19]

Most treatments are associated with some known risks and contraindications vary widely based on the treatment administered. Therefore, discussion of available treatments and

procedures applicable to the individual patient rely on mutual communication between the patient and physician, weighing the potential risks and benefits for that patient.

II. METHODS

This clinical practice guideline and the systematic review upon which it is based evaluate the effectiveness of diagnosis of and treatments for osteochondritis dissecans of the knee. This section describes the methods used to prepare this guideline and systematic review, including search strategies used to identify literature, criteria for selecting eligible articles, determining the strength of the evidence, data extraction, methods of statistical analysis, and the review and approval of the guideline. The methods used to perform this systematic review were employed to minimize bias in the selection, appraisal, and analysis of the available evidence.[20, 21] These processes are vital to the development of reliable, transparent, and accurate clinical recommendations for treating osteochondritis dissecans.

This guideline and systematic review were prepared by The Diagnosis and Treatment of Osteochondritis Dissecans of the Knee guideline work group with the assistance of the AAOS Clinical Practice Guidelines Unit in the Department of Research and Scientific Affairs at the AAOS (Appendix I).

To develop this guideline, the work group held an introductory meeting to develop the scope of the guideline on April 19th 2009. Upon completion of the systematic review, the work group met again on April 10th and 11th, 2010 to write and vote on the final recommendations and associated rationales for each recommendation based on the evidence.

The resulting draft guidelines are then peer reviewed, edited in response to that review, and then sent for public commentary where after additional edits are made. Thereafter, the draft guideline is sequentially sent for approval by the AAOS Evidence Based Practice Committee, AAOS Guidelines and Technology Oversight Committee, the AAOS Council on Research, Quality Assessment, and Technology, and the AAOS Board of Directors (Appendix II provides a description of the AAOS bodies involved in the approval process). All AAOS guidelines are reviewed and updated or retired every five years in accordance with the criteria of the National Guideline Clearinghouse.

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, not as final recommendations or conclusions. Preliminary recommendations are almost always modified on the basis of the results of the systematic review. Once established, these *a priori* preliminary recommendations cannot be modified until the final work group meeting, they must be addressed by the systematic review, and the relevant review results must be presented in the final guideline.

STUDY SELECTION CRITERIA

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

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

- Investigates osteochondritis dissecans of the knee in otherwise healthy children and adults without other conditions that can cause OCD and without comorbid conditions.
- is not investigating osteochondral fractures or ligament instability
- Does not combine results of skeletally immature patients with skeletally mature patients.
- Is a full article report of a clinical study (i.e., retrospective case series, medical records review, meeting abstracts, historical articles, editorials, letters, and commentaries are excluded)
- Articles studying natural history and prognostic factors can be retrospective case series.
- Diagnostic case control studies will be excluded
- appears in a peer-reviewed publication
- has 10 or more patients per group
- is of humans
- is published in English
- is published in or after 1966
- reports results quantitatively
- has follow up of at least two years except for when healing or adverse events are the outcome
- has ≥ 50% patient follow-up (if the follow-up is >50% but <80%, the study quality will be downgraded)
- is not an in vitro study
- is not a biomechanical study
- is not performed on cadavers

INCLUSION OF STUDIES WITH MIXED PATIENT POPULATIONS

The work group specified *a priori* to the literature search that the studies must enroll and report the results of patients with osteochondritis dissecans of the knee. Studies with mixed populations must report the results of patients with osteochondritis dissecans of the knee separately or if the results are combined, eighty-percent of the patient population must be of patients with osteochondritis dissecans of the knee in order to consider the study for inclusion in this guideline.

BEST AVAILABLE EVIDENCE

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

OUTCOMES CONSIDERED

Clinical studies often report many different outcomes. For this guideline, only patient-oriented outcomes are included, and surrogate/intermediate outcomes are not considered. Surrogate outcome measures are laboratory measurements or another physical sign used as substitutes for a clinically meaningful end point that measures directly how a patient feels, functions, or survives.[22] Radiographic results are an example of a surrogate outcome.

For outcomes measured using "paper and pencil" instruments (e.g. the visual analogue scale), the results using validated instruments are considered the best available evidence. In the absence of results using validated instruments, results using non-validated instruments are considered as the best available evidence and the strength of the recommendation is lowered.

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 March 24, 2010. We searched four electronic databases; PubMed, EMBASE, CINAHL, and The Cochrane Central Register of Controlled Trials. Strategies for searching electronic databases were constructed by a Medical Librarian using previously published search strategies to identify relevant studies.[23-29]

We supplemented searches of electronic databases with manual screening of the bibliographies of all retrieved publications. We also searched the bibliographies of recent systematic reviews and other review articles for potentially relevant citations. Finally,

work group members provided a list of potentially relevant studies that were not identified by our searches. All articles identified were subject to the study selection criteria listed above.

We did not include systematic reviews compiled by others or guidelines developed by other organizations. These documents are developed using different inclusion criteria than those specified by the AAOS work group. Therefore they may include studies that do not meet our inclusion criteria. We recalled these documents, if the abstract suggested they might provide an answer to one of our recommendations, and searched their bibliographies for additional studies to supplement our systematic review.

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

DATA EXTRACTION

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

The work group specified *a priori* to the literature search that data would be stratified by joint but that mixed studies could be accepted and reported as such. When studies did not separate the data by joint, it is not possible to report them separately. If a study with mixed joints reported the data for each joint we reported them as such. If a study reported mixed joints but had less than 25 patients per joint, the analyst reported only the mixed data.

JUDGING THE QUALITY OF EVIDENCE

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

Assigning a level of evidence on the basis of study design plus other quality characteristics ties the levels of evidence we report more closely to quality than levels of evidence based only on study design. Because we tie quality to levels of evidence, we are able to characterize the confidence one can have in their results. Accordingly, we characterize the confidence one can have in Level I evidence as high, the confidence one can have in Level II and III evidence as moderate, and the confidence one can have in Level IV and V evidence as low. Similarly, throughout the guideline we refer to Level I evidence as reliable, Level II and III evidence as moderately reliable, and Level IV and V evidence as not reliable.

DIAGNOSTIC STUDIES

In studies investigating a diagnostic test, we used the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) instrument (Appendix VI) to identify potential bias and assess variability and the quality of reporting in studies reporting the effectiveness of diagnostic techniques. [30] Studies without any indication of bias are categorized as high quality studies. The quality of a study that has bias in the study design (disease progression, partial verification), index test description, or clinical data was lowered for each bias present. Quality could be further downgraded if greater than 50% of the QUADAS (at least 3 of the 5) questions that assess the quality of reporting determined there was important information missing. Studies that have bias known to affect measures of diagnostic accuracy (i.e. spectrum bias, incorporation bias) were considered very low quality and not considered for analysis.

TREATMENT STUDIES

In studies investigating the result of treatment, we assessed the quality of the evidence for each outcome at each time point reported in a study. We did not simply assess the overall quality of a study. Our approach follows the recommendations of the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) working group[31] as well as others.[32]

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 quality 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 high quality evidence, all results presented in non-randomized controlled trials and other prospective comparative studies were initially categorized as moderate quality, all results presented in retrospective comparative and case-control studies were initially categorized as low quality, and all results presented in prospective case-series reports were initially categorized as low quality. We next assessed each outcome at each reported time point using a quality questionnaire and, when quality standards were not met, downgraded the level of evidence (for this outcome at this time point) by one level (see Appendix VI).

PROGNOSTIC STUDIES

In studies investigating the effect of a characteristic on the outcome of disease, we assessed quality using a two step process including a quality questionnaire (Appendix VI). The quality questionnaire was developed from previously published literature addressing the use and analysis of prognostic variables.[33, 34] All studies were initially assigned as high quality and when quality standards were not met, as determined by the

quality questionnaire, the study quality was lowered. The lowering of study quality was cumulative. Studies with five or more flaws indicated by the quality questionnaire were reduced to very low quality and not considered in our analysis.

DEFINING THE STRENGTH OF THE RECOMMENDATIONS

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

Strength of recommendation expresses the degree of confidence one can have in a recommendation. As such, the strength expresses how possible it is that a recommendation will be overturned by future evidence. It is very difficult for future evidence to overturn a recommendation that is based on many high quality randomized controlled trials that show a large effect. It is much more likely that future evidence will overturn recommendations derived from a few small case series. Consequently, recommendations based on the former kind of evidence are given a high strength of recommendation and recommendations based on the latter kind of evidence are given a low strength.

To develop the strength of a recommendation, AAOS staff first assigned a preliminary strength for each recommendation that took only the quality and quantity of the available evidence into account (see Table 1). Work group members then modified the preliminary strength using the 'Form for Assigning Strength of Recommendation (Interventions)' shown in Appendix VII.

Table 1 Strength of recommendation descriptions

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

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

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

Table 2 AAOS guideline language

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

*Consensus based recommendations are made according to specific criteria. These criteria can be found in Appendix VI.

CONSENSUS DEVELOPMENT

The recommendations and their strength were voted on using a structured voting technique known as the nominal group technique.[35] We present details of this technique in Appendix VIII. Voting on guideline recommendations was conducted using a secret ballot and work group members were blinded to the responses of other members. If disagreement between work group members was significant, there was further discussion to see whether the disagreement(s) could be resolved. Up to three rounds of voting were held to attempt to resolve disagreements. If disagreements were not resolved following three voting rounds, no recommendation was adopted. Lack of agreement is a reason that the strength for some recommendations is labeled "Inconclusive."

STATISTICAL METHODS

Likelihood ratios, sensitivity, specificity and 95% confidence intervals were calculated to determine the accuracy of diagnostic modalities based on two by two diagnostic contingency tables extracted from the included studies. When summary values of sensitivity, specificity, or other diagnostic performance measures were reported, estimates of the diagnostic contingency table were used to calculate likelihood ratios. Likelihood ratios (LR) indicate the magnitude of the change in probability of disease due to a given test result. For example, a positive likelihood ratio of 10 indicates that a positive test result is 10 times more common in patients with disease than in patients without disease. Likelihood ratios are interpreted according to previously published values, as seen in Table 3. [36]

Table 3 Interpreting Likelihood Ratios

Positive Likelihood Ratio	Negative Likelihood Ratio	Interpretation
>10	<0.1	Large and conclusive change in probability
5-10	0.1-0.2	Moderate change in probability
2-5	0.2-0.5	Small (but sometimes important) change in probability
1-2	0.5-1	Small (and rarely important) change in probability

When possible the results of statistical analysis conducted by the AAOS Clinical Practice Guidelines Unit using STATA 10.0 (StataCorp LP, College Station, Texas) are reported. The program was used to determine the magnitude of the treatment effect. For data reported as means (and associated measures of dispersion) the mean difference between groups was calculated. For proportions, we report the number of patients with the outcome and without the outcome and the associated percentages. The variance of the arcsine difference was used to determine statistical significance ($p < 0.05$) of proportions.[37]

To assess the power of an outcome to detect a statistically significant difference in a study we determined whether the number of patients in the study was sufficient to detect a small, medium, or large effect, while assuming an alpha of 0.05 as the significance level, 80% power, and Cohen's definitions of small, medium, and large effects (a small effect is $d = 0.2$, a medium effect is $d = 0.5$, and a large effect is $d = 0.8$).[38] When a comparative study with a non-significant difference was unable to detect a large effect it was categorized as low power. Studies enrolling only a series of similar cases that were unable to detect a large effect were categorized as low power. Studies able to detect large effects or with statistically significant differences were categorized as high power.

When published studies report measures of dispersion other than the standard deviation the value is estimated to facilitate calculation of the treatment effect. In studies that report standard errors, confidence intervals, or p-values the standard deviation was back-calculated. In studies that only report the median, range, and size of the trial, we estimated the means and variances according to a published method.[39] Studies that report results in graphical form were analyzed with TechDig 2.0 (Ronald B. Jones, Mundelein, Illinois) to estimate the mean and variance.

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

PEER REVIEW

The draft of the guideline and evidence report was peer reviewed by an expert, outside advisory panel that was nominated *a priori* by the physician work group prior to the development of the guideline. The physician members of the AAOS Guidelines and Technology Oversight Committee, the Evidence Based Practice Committee, and the Occupational Health and Workers' Compensation Committee also provided peer review of the draft document. Peer review was accomplished using a structured peer review form (See Appendix IX). The draft guideline was sent to a total of 11 reviewers and 6 returned reviews (See Appendix X). The disposition of all non-editorial peer review comments was documented and accompanied this guideline through the public commentary and the AAOS guideline approval process. The peer reviewer comments, our responses and the final guideline are posted to the AAOS website upon approval of the AAOS Board of Directors.

PUBLIC COMMENTARY

After modifying the draft in response to peer review, the guideline was distributed 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 concerning the content of this guideline and the AAOS guideline development process. Of these, 2 returned public comments.

THE AAOS GUIDELINE APPROVAL PROCESS

Following public commentary, the work group and clinical practice guidelines unit edited the draft if public comments indicated changes were necessary based on the evidence. This final guideline draft, peer review comments and our responses as well as a summary of all changes made during the review process was then forwarded into the approval process. The guideline draft was sequentially approved by the AAOS Guidelines Oversight Committee, the AAOS Evidence -Based Practice Committee, the AAOS Council on Research, Quality Assessment, and Technology, and the AAOS Board of Directors. Descriptions of these bodies are provided in Appendix II No changes to the draft may occur during the approval process; all entities vote to approve or reject the document.

REVISION PLANS

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

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 It is available for free.

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

III. RECOMMENDATIONS AND SUPPORTING DATA

RECOMMENDATION 1

In a patient with knee symptoms (pain, swelling, locking, catching, popping, giving way) and/or signs (tenderness, effusion, loss of motion, crepitus), x-rays (including AP, lateral, sunrise/Merchant, and tunnel views) are an option.

Strength of Recommendation: Limited

Rationale

Patients with an OCD lesion often present with complaints of knee pain and swelling. In addition, patients may note sensations of locking (motion of the knee is halted), catching (motion is partially inhibited), popping, or giving way. Physical examination may reveal tenderness, effusion, loss of motion, or crepitus.

AAOS conducted a systematic review that identified one diagnostic study which evaluated the diagnostic performance of clinical examination with radiographs and of selective MRI in the evaluation of intra-articular knee disorders by comparing these findings with arthroscopic findings.[40] Clinical diagnosis was made on the basis of history, physical examination, and standard radiographs (AP, lateral, Merchant, and tunnel views). MRI studies were ordered selectively on the basis of clinical discretion. Arthroscopic evaluation was performed in the subset of patients that required surgery, based on clinical diagnosis and MRI findings if an MRI was performed. The clinical diagnosis (from the initial visit), MRI diagnosis (from the MRI report), and the arthroscopic diagnosis (from the operative report) were retrospectively reviewed and compared. Since only a subset of all patients that underwent evaluation of intra-articular knee disorders proceeded to arthroscopic evaluation, this diagnostic study does not universally apply the reference standard of arthroscopy. Consequently, we assessed this retrospective diagnostic study without a universally applied reference standard as a Level II study. Since only a single study is available to support this recommendation, the strength of recommendation is limited.

Supporting Evidence

One Level II study reports the diagnostic performance of a clinical exam by a pediatric orthopaedic surgeon, including consideration of AP, lateral, tunnel, and Merchant radiographs.[40] This study enrolled 125 patients with various knee lesions, 22 of which were diagnosed as osteochondritis dissecans (OCD) during arthroscopic examination.

Diagnostic performance estimates from this study reflect the value of cumulative patient history, examination, and radiographs to distinguish OCD from other lesions.

Analysis of likelihood ratios (LR) and associated confidence intervals indicates clinical exam by a pediatric orthopaedic surgeon with consideration of radiographs is a good or moderately good rule in test for OCD and a moderately good, weak, or poor rule out test for OCD (able 4).

STUDY QUALITY

● = Yes ○ = No ? = Unclear	Kocher 2001
Level of Evidence	II
Diagnostic Test	clinical exam and x-rays
n	125
QUADAS* Question:	
Full Patient Spectrum	●
Patient Selection Criteria Described	●
Reference Standard Classifies Condition	●
Disease Progression Absent	●
Partial Verification Avoided	○
Differential Verification Avoided	●
Independent Reference Standard and Index Test	●
Index Test Execution Described	●
Reference Standard Execution Described	●
Index Test Interpreted Without Reference Standard	●
Reference Standard Interpreted Without Index Test	○
Usual Clinical Data Available	●
Uninterpretable/ Indeterminate Results Reported	●
Withdrawals Explained	●

*QUADAS: Quality Assessment of Diagnostic Accuracy Studies

DIAGNOSIS OF OCD USING EXAMINATION AND RADIOGRAPHS

Table 4 Diagnostic performance of clinical exam including radiographs - Recommendation 1

Author	n	Index Test	Reference	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio	Sensitivity (95% CI)	Specificity (95% CI)	TP	FP	FN	TN
Kocher 2001	125	exam, x-rays	Arthroscopy	26.53 (8.50, 82.77)*	0.23 (0.11, 0.51)*	0.773† (0.55, 0.92)*	0.979† (0.92, 0.99)*	17*	3*	5*	100*

* estimated values based on reported sensitivity, specificity, and reported arthroscopic diagnoses; † reported by authors; CI: confidence interval; TP: true positive; FP: false positive; FN: false negative; TN: true negative; nr: not reported

EXCLUDED STUDIES

Table 5 Excluded Studies - Recommendation 1

Author	Title	Reason for Exclusion
Kijowski 2008	Juvenile versus adult osteochondritis dissecans of the knee: appropriate MR imaging criteria for instability	Insufficient data for diagnostic accuracy of radiographs
Choi 2007	Magnetic resonance imaging in the evaluation of osteochondritis dissecans of the patella	Insufficient data for diagnostic accuracy
Gebarski 2005	Stage-I osteochondritis dissecans versus normal variants of ossification in the knee in children	Insufficient data for diagnostic accuracy
Luhmann 2005	Magnetic resonance imaging of the knee in children and adolescents. Its role in clinical decision-making	Insufficient data for diagnostic accuracy of radiographs
Vellala 2004	Single photon emission computed tomography scanning in the diagnosis of knee pathology	Less than 10 patients with OCD
Boutin 2003	MR imaging features of osteochondritis dissecans of the femoral sulcus	Incorporation bias
Conrad 2003	Osteochondritis dissecans: Wilson's sign revisited	Not relevant,clinical signs not considered for this guideline
Pill 2003	Role of magnetic resonance imaging and clinical criteria in predicting successful nonoperative treatment of osteochondritis dissecans in children	Insufficient data for diagnostic accuracy
O'Connor 2002	Osteochondritis dissecans of the knee in children. A comparison of MRI and arthroscopic findings	Insufficient data for diagnostic accuracy of radiographs
Odgaard 2002	Clinical decision making in the acutely injured knee based on repeat clinical examination and MRI	Less than 10 patients with OCD
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Insufficient data for diagnostic accuracy
Paletta 1998	The prognostic value of quantitative bone scan in knee osteochondritis dissecans. A preliminary experience	Insufficient data for diagnostic accuracy
Yoshida 1998	Osteochondritis dissecans of the femoral condyle in the growth stage	Insufficient data for diagnostic accuracy
De Smet 1997	Untreated osteochondritis dissecans of the femoral condyles: prediction of patient outcome using radiographic and MR findings	Incorrect reference standard
De Smet 1996	Reassessment of the MR criteria for stability of osteochondritis dissecans in the knee and ankle	Combines results of knee and ankle OCD (<80% knee)
Kramer 1992	MR contrast arthrography (MRA) in osteochondrosis dissecans	Insufficient data for diagnostic accuracy of radiographs

Table 5 Excluded Studies - Recommendation 1

Author	Title	Reason for Exclusion
Dipaola 1991	Characterizing osteochondral lesions by magnetic resonance imaging	Combines results of knee and ankle OCD (<80% knee)
De Smet 1990	Osteochondritis dissecans of the knee: value of MR imaging in determining lesion stability and the presence of articular cartilage defects	Insufficient data for diagnostic accuracy of radiographs
Nelson 1990	Osteochondritis dissecans of the talus and knee: prospective comparison of MR and arthroscopic classifications	Combines results of knee and ankle OCD (<80% knee)
Litchman 1988	Computerized blood flow analysis for decision making in the treatment of osteochondritis dissecans	No quantitative data
McCullough 1988	Dynamic bone scintigraphy in osteochondritis dissecans	Uses radiographs as reference standard
Hartzman 1987	MR imaging of the knee. Part II. Chronic disorders	Less than 10 patients with OCD
Mesgarzadeh 1987	Osteochondritis dissecans: analysis of mechanical stability with radiography, scintigraphy, and MR imaging	Incorporation bias
McCullough 1986	Computerized blood-flow analysis in osteochondritis dissecans	Less than 10 patients
Cahill 1983	99m-Technetium phosphate compound joint scintigraphy in the management of juvenile osteochondritis dissecans of the femoral condyles	No quantitative data
Bramson 1975	Double contrast knee arthrography in children	Less than 10 patients with OCD
Wershba 1975	Double contrast knee arthrography in the evaluation of osteochondritis dissecans	Insufficient data for diagnostic accuracy
Nicholas 1970	Double-contrast arthrography of the knee. Its value in the management of two hundred and twenty-five knee derangements	Insufficient data for diagnostic accuracy

RECOMMENDATION 2

In a patient with a known OCD lesion on x-ray, an MRI of the knee is an option to characterize the OCD lesion or when concomitant knee pathology is suspected such as meniscal pathology, ACL injury, or articular cartilage injury.

Strength of Recommendation: High

Rationale

AAOS conducted a systematic review that identified two diagnostic studies[40, 41] addressing this recommendation. One of these studies evaluated the diagnostic performance of clinical examination with radiographs and of selective MRI in the evaluation of intra-articular knee disorders by comparing these findings with arthroscopic findings.[40] The clinical diagnosis (from the initial visit), MRI diagnosis (from the MRI report), and the arthroscopic diagnosis (from the operative report) were retrospectively reviewed and compared. Since only a subset of all patients that underwent evaluation of intra-articular knee disorders proceeded to arthroscopic evaluation, this diagnostic study does not universally apply the reference standard of arthroscopy. Consequently, this retrospective diagnostic study without a universally applied reference standard was evaluated as a Level II study.

Similarly, the second diagnostic study identified in the systematic review, prospectively evaluated all consecutive patients undergoing knee arthroscopy who had a preoperative MRI.[41] Again, this study only reports on the subset of patients that required surgery; therefore, this diagnostic study does not universally apply the reference standard of arthroscopy. Consequently, this prospective diagnostic study without a universally applied reference standard is also evaluated as a Level II study.

These Level II studies, when considered together, may have supported a moderate strength of recommendation. However, these studies found that both x-ray and MRI are good rule in tests and do not address the incremental diagnostic value of an MRI in the setting of known OCD determined by x-ray. That is, these studies do not compare the diagnostic performance of clinical examination with standard radiographs to clinical examination with standard radiographs and an MRI; therefore we downgraded the strength of this recommendation to limited.

In addition to identifying the presence of OCD lesions and distinguishing OCD lesions from other intra-articular pathology, an MRI may be used as an adjunct to clinical examination with radiographs to provide additional information that will guide therapeutic decision-making. Of the 5 therapeutic studies[42-46] that were included in the development of this guideline, three studies [42-44] report the acquisition of an MRI at enrollment and three studies[42, 44, 45] report the acquisition of an MRI at follow-up evaluation. Further, one prognostic study[19] predicts the healing potential of stable OCD lesions, utilizing a multivariable logistic regression model. Of all of the variables that were considered (including sex, side, location, symptoms, knee dimensions, and lesion dimensions), only knee symptoms as well as normalized length and normalized width of the OCD lesion as measured on MRI were found to be predictive of healing potential.

Of note, three studies[47-49] correlated MRI findings with arthroscopic findings in patients with OCD of the knee. The evidence for assessment of stability of an OCD lesion was inconsistent.

Supporting Evidence

A single study assessed the pre-operative diagnosis of a pediatric orthopaedic surgeon, which included clinical examination, radiographs, and consideration of the MRI findings.[41] This study enrolled 131 patients with various knee lesions, 19 of which were diagnosed as having OCD during arthroscopic examination. Diagnostic performance estimates from this study reflect the value of a pediatric orthopaedic surgeon's pre-operative diagnosis to correctly identify OCD from several other lesions. Analysis of likelihood ratios (LR) and associated confidence intervals indicates that diagnosis based on exam, x-rays, and MRI findings is a good rule in and a good, moderately good, or weak rule out test for OCD (Table 7). However, the use of a single surgeon's pre-operative diagnosis reduces the generalizability of these results.

Two studies evaluated the ability of MRI to distinguish OCD from several other lesions.[40, 41] The studies enrolled 256 patients with various knee lesions, 41 of which were diagnosed as having OCD during arthroscopic examination. Likelihood ratios and the associated confidence intervals indicate MRI is a good or moderately good rule in test and a good, moderately good, or weak rule out test for OCD (able 8).

In the three remaining studies (n = 124), MRI was evaluated for the ability to diagnose instability of the osteochondritis dissecans.[47-49] Instability at MRI was based on similar criteria, including high signal rims/lines, cysts, and focal defects (Table 9). One study reported the results of skeletally mature patients separately from skeletally immature patients.[48] Ninety-one percent (91%) of the patients in one study were skeletally immature [49] and 81% of the patients skeletally mature in the remaining study.[47] Thus, we analyzed the likelihood ratios and the associated confidence intervals for skeletally immature patients and skeletally mature patients separately.

The analysis in skeletally immature patients indicates MRI is good, moderately good, weak, or poor as a rule in and rule out test for instability of OCD (Table 10).

MRI is a good, moderately good, weak, or poor rule in test for OCD instability in skeletally mature patients and a good, moderately good, or weak rule out test for OCD instability in skeletally mature patients (able 11).

STUDY QUALITY

Table 6 Quality of diagnostic studies - Recommendation 2

● = Yes ○ = No ? = Unclear	Kijowski 2008	Luhmann 2005	Luhmann 2005	O'Connor 2002	Kocher 2001	De Smet 1990
Level of Evidence	II	II	II	II	II	II
Diagnostic Test	MRI	MRI	MRI+ exam	MRI	MRI	MRI
n	70	131	131	33	125	21
QUADAS Question:						
Full Patient Spectrum	●	●	●	●	●	●
Patient Selection Criteria Described	●	●	●	●	●	●
Reference Standard Classifies Condition	●	●	●	●	●	●
Disease Progression Absent	●	●	●	●	●	●
Partial Verification Avoided	○	○	○	○	○	○
Differential Verification Avoided	●	●	●	●	●	●
Independent Reference Standard and Index Test	●	●	●	●	●	●
Index Test Execution Described	●	●	●	●	●	●
Reference Standard Execution Described	●	●	●	●	●	●
Index Test Interpreted Without Reference Standard	●	●	●	●	●	●
Reference Standard Interpreted Without Index Test	?	○	○	?	○	?
Usual Clinical Data Available	?	●	●	?	●	?
Uninterpretable/ Indeterminate Results Reported	●	●	●	●	●	●
Withdrawals Explained	●	●	●	●	●	●

QUADAS: Quality Assessment of Diagnostic Accuracy Studies

DIAGNOSIS OF OCD USING EXAMINATION, RADIOGRAPHS, AND MRI

Table 7 Diagnostic performance of examination, radiographs, and MRI - Recommendation 2

Author	n	Index Test	Reference	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio	Sensitivity (95% CI)	Specificity (95% CI)	TP	FP	FN	TN
Luhmann 2005	131	exam, x-rays, MRI	Arthroscopy	209.05 (13.12, 3331.09)*	0.08 (0.02, 0.35)*	0.944 (0.755, 0.997)†	1.00 (0.962, 1.00)†	18*	0*	1*	112*

* estimated values based on reported sensitivity, specificity, and reported arthroscopic diagnoses; † reported by authors CI: confidence interval; TP: true positive; FP: false positive; FN: false negative; TN: true negative

DIAGNOSIS OF OCD USING MRI

Table 8 Diagnostic performance of MRI - Recommendation 2

Author	n	Index Test	Reference	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio	Sensitivity (95% CI)	Specificity (95% CI)	TP	FP	FN	TN
Luhmann 2005	131	MRI	Arthroscopy	17.53 (7.22, 42.57)*	0.22 (0.09, 0.53)*	0.778 (0.547,	0.949 (0.881,	15*	5*	4*	106*
Kocher 2001	125	MRI	Arthroscopy	31.21 (10.16, 95.93)*	0.09 (0.02, 0.35)*	0.909† (0.71, 0.99)*	0.979† (0.92, 0.99)*	20*	3*	2*	100*

* estimated values based on reported sensitivity, specificity, and reported arthroscopic diagnoses; † reported by authors CI: confidence interval; TP: true positive; FP: false positive; FN: false negative; TN: true negative; nr: not reported

DIAGNOSIS OF OCD INSTABILITY USING MRI

Table 9 MRI criteria for instability from included studies - Recommendation 2

Study	MRI criteria for instability
Kijowski 2008	high T2 signal intensity rim or cyst or high T2 signal fracture line thru cartilage or fluid filled defect
O'Connor 2002	high T2 signal behind fragment or articular cartilage defect or loose body
De Smet 1990	high signal line fracture/fragment interface or disruption of subchondral bone plate or adjacent focal cyst or displaced fragments or articular cartilage defects

Table 10 Diagnostic performance of MRI (instability, skeletally immature) - Recommendation 2

Author	n	Index Test	Reference	Positive Likelihood Ratio	Negative Likelihood Ratio	Sensitivity (95% CI)	Specificity (95% CI)	TP	FP	FN	TN
Kijowski 2008	36	MRI for instability	Arthroscopy	1.11 (0.93, 1.33)	0.22 (0.01, 4.33)	1.00 (0.80, 1.00)	0.11 (0.01, 0.33)	17	17	0	2
O'Connor 2002	33	MRI for instabilit	Arthroscopy	14.93 (2.17, 102.56)	0.23 (0.08, 0.62)	0.79 (0.52, 0.92)	0.95 (0.75, 0.99)	11	1	3	18

all values based on 2x2 data extracted from studies

Table 11 Diagnostic performance of MRI (instability, skeletally mature) - Recommendation 2

Author	n	Index Test	Reference	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio	Sensitivity (95% CI)	Specificity (95% CI)	TP	FP	FN	TN
Kijowski 2008	34	MRI for instability	Arthroscopy	17.67 (1.19, 261.36)	0.02 (0.00, 0.31)	1.00 (0.87, 1.00)	1.00 (0.63, 1.00)	26	0	0	8
De Smet 1990	21	MRI for instability	Arthroscopy	1.30 (0.58, 2.91)	0.10 (0.00, 3.63)	1.00 (0.80, 1.00)	0.00 (0.00, 0.80)	20	1	0	0

all values based on 2x2 data extracted from studies

EXCLUDED STUDIES

Table 12 Excluded Studies - Recommendation 2

Author	Title	Reason for Exclusion
Choi 2007	Magnetic resonance imaging in the evaluation of osteochondritis dissecans of the patella	Insufficient data for diagnostic accuracy
Gebarski 2005	Stage-I osteochondritis dissecans versus normal variants of ossification in the knee in children	Insufficient data for diagnostic accuracy
Vellala 2004	Single photon emission computed tomography scanning in the diagnosis of knee pathology	Less than 10 patients with OCD
Boutin 2003	MR imaging features of osteochondritis dissecans of the femoral sulcus	Incorporation bias
Conrad 2003	Osteochondritis dissecans: Wilson's sign revisited	Not relevant, clinical signs not considered for this guideline
Pill 2003	Role of magnetic resonance imaging and clinical criteria in predicting successful nonoperative treatment of osteochondritis dissecans in children	Insufficient data for diagnostic accuracy
Odgaard 2002	Clinical decision making in the acutely injured knee based on repeat clinical examination and MRI	Less than 10 patients with OCD
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Insufficient data for diagnostic accuracy
Paletta 1998	The prognostic value of quantitative bone scan in knee osteochondritis dissecans. A preliminary experience	Insufficient data for diagnostic accuracy
Yoshida 1998	Osteochondritis dissecans of the femoral condyle in the growth stage	Insufficient data for diagnostic accuracy
De Smet 1997	Untreated osteochondritis dissecans of the femoral condyles: prediction of patient outcome using radiographic and MR findings	Incorrect reference standard
De Smet 1996	Reassessment of the MR criteria for stability of osteochondritis dissecans in the knee and ankle	Combines results of knee and ankle OCD (<80% knee)
Kramer 1992	MR contrast arthrography (MRA) in osteochondrosis dissecans	Not best available evidence
Dipaola 1991	Characterizing osteochondral lesions by magnetic resonance imaging	Combines results of knee and ankle OCD (<80% knee)
Nelson 1990	Osteochondritis dissecans of the talus and knee: prospective comparison of MR and arthroscopic classifications	Combines results of knee and ankle OCD (<80% knee)
Litchman 1988	Computerized blood flow analysis for decision making in the treatment of osteochondritis dissecans	No quantitative data

Table 12 Excluded Studies - Recommendation 2

Author	Title	Reason for Exclusion
McCullough 1988	Dynamic bone scintigraphy in osteochondritis dissecans	Incorrect reference standard
Hartzman 1987	MR imaging of the knee. Part II. Chronic disorders	Less than 10 patients with OCD
Mesgarzadeh 1987	Osteochondritis dissecans: analysis of mechanical stability with radiography, scintigraphy, and MR imaging	Incorporation bias
McCullough 1986	Computerized blood-flow analysis in osteochondritis dissecans	Less than 10 patients
Cahill 1983	99m-Technetium phosphate compound joint scintigraphy in the management of juvenile osteochondritis dissecans of the femoral condyles	No quantitative data
Bramson 1975	Double contrast knee arthrography in children	Less than 10 patients with OCD
Wershba 1975	Double contrast knee arthrography in the evaluation of osteochondritis dissecans	Insufficient data for diagnostic accuracy
Nicholas 1970	Double-contrast arthrography of the knee. Its value in the management of two hundred and twenty-five knee derangements	Insufficient data for diagnostic accuracy

RECOMMENDATION 3

S**ymptomatic** skeletally immature patients with unstable or displaced OCD lesions be offered the option of surgery.

Strength of Recommendation: Limited

Rationale

Children who are skeletally immature (i.e., those with open physes) who exhibit continued or progressing symptoms and signs of loosening (usually detected by MRI) are unlikely to heal without treatment. This is also true of skeletally mature patients with OCD lesions who have a history of not healing and/or there are already signs of loosening. Further, these skeletally immature and mature patients, because of loss of bone and cartilage, may be at higher risk of developing severe osteoarthritis (osteoarthrosis) at an early age. Although the exact degree of risk is not known, the work group deemed that it was imprudent to ignore it.

In issuing this consensus recommendation, the work group is issuing a recommendation consistent with current medical practice. However, the work group also acknowledges the paucity of evidence on the effectiveness of fixation of unstable OCD lesions, and that surgery entails risks. These risks include, but are not limited to, bleeding, infection, damage to nerves and blood vessels, venous thromboembolic events, anesthesia complications, and surgical failure. Again, however, not performing surgery also carries a risk, irreversible osteoarthritis/osteoarthrosis. This latter risk is of particular concern since effective treatments for young patients with severe osteoarthritis (osteoarthrosis) are limited. It is, therefore, the opinion of the work group that symptomatic patients with salvageable unstable or displaced OCD lesions (the work group defines “salvageable, unstable or displaced OCD lesions”, either unstable but in situ or displaced, as those that may be restored, using the patient’s native tissue from the osteochondritis region) be given the option of balancing the risks of performing or not performing surgery against the benefits of performing or not performing it. One potential benefit of surgery is the prevention or delay of severe osteoarthritis (osteoarthrosis). Another potential benefit is that these patients will be relieved of their existing symptoms.

The work group stresses that the choice to proceed with surgery is part of a shared decision making process between the patient, family, and physician. Offering patients the

option of surgery is not a mandate that they have it. Patients can, and sometimes do, decline surgery.

Offering patients surgery requires informed consent. Failure to inform patients concerning the possible risks of surgical treatment is unethical and precludes them from surgery. Informed consent should provide patients with enough information about surgery to make a sound judgment about whether they wish to proceed to surgery given their individual situation.

The present recommendation does not apply to all patients with OCD. In many skeletal immature children (i.e., those with open physes), these lesions heal without treatment. This is particularly true in children who have incidentally discovered lesions and have minimal symptoms. Accordingly, the work group makes no recommendations about surgery or physical therapy for such patients.

Supporting Evidence

There is no evidence to address this recommendation.

EXCLUDED STUDIES

Table 25 Excluded studies - Recommendation 3

Author	Title	Reason for Exclusion
Magnussen 2009	Does operative fixation of an osteochondritis dissecans loose body result in healing and long-term maintenance of knee function?	Combines the results of skeletally immature patients and skeletally mature patients
Kocher 2007	Internal fixation of juvenile osteochondritis dissecans lesions of the knee	No baseline data reported
Gomoll 2007	Internal fixation of unstable Cahill Type-2C osteochondritis dissecans lesions of the knee in adolescent patients	Combines the results of skeletally immature and skeletally mature patients/ No baseline data reported
Din 2006	Internal fixation of undisplaced lesions of osteochondritis dissecans in the knee	Retrospective case series
Makino 2005	Arthroscopic fixation of osteochondritis dissecans of the knee: clinical, magnetic resonance imaging, and arthroscopic follow-up	Less than 80% -Combines results of children and adults
Jurgensen 2002	Arthroscopic versus conservative treatment of osteochondritis dissecans of the knee: value of magnetic resonance imaging in therapy planning and follow-up	Combines the results of skeletally immature patients and skeletally mature patients
Kivisto 2002	Arthroscopic repair of osteochondritis dissecans of the femoral condyles with metal staple fixation: a report of 28 cases	Combines the results of skeletally immature patients and skeletally mature patients/Retrospective case series
Zmerly 2000	The treatment of cartilage injuries in footballers	Combines the results of Combines the results of skeletally immature patients and skeletally mature patients and SSM patients
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Combines the results of skeletally immature patients and skeletally mature patients and the results of multiple treatments
Mitsuoka 1999	Osteochondritis dissecans of the lateral femoral condyle of the knee joint	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients per group
Havulinna 1995	Long-term results of Smillie pin fixation of osteochondritis dissecans in the femoral condyles	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients
Cugat 1993	Osteochondritis dissecans: A historical review and its treatment with cannulated screws	Less than 80% Combines the results of skeletally immature patients and skeletally mature patients patients w/ OCD - combines adults and children

Table 25 Excluded studies - Recommendation 3

Author	Title	Reason for Exclusion
Johnson 1990	Osteochondritis dissecans of the knee: arthroscopic compression screw fixation	Combines the results of skeletally immature patients and skeletally mature patients and the results of multiple treatments
Desai 1987	Osteochondritis dissecans of the patella	Less than 10 patients per group
Hughston 1984	Osteochondritis dissecans of the femoral condyles	Combines the results of skeletally immature patients and skeletally mature patients
Bruckl 1984	Osteochondrosis dissecans of the knee. Results of operative treatment in juveniles	Reports the results of multiple Txs/ Does not specifiy patient population
Guhl 1982	Arthroscopic treatment of osteochondritis dissecans	Not relevant - does apply to patient population
Lindholm 1979	Treatment of juvenile osteochondritis dissecans in the knee	Combines the results of adults and children
Aichroth 1971	Osteochondritis dissecans of the knee. A clinical survey	Less than 10 patients per Tx group
Langer 1971	Osteochondritis dissecans and anomalous centres of ossification: a review of 80 lesions in 61 patients	Retrospective case series/Combines adult and children

PROGNOSTIC EVIDENCE

One Level V study [56] (n = 24) reported the results of post hoc analyses of any prognostic factors that might influence the results of skeletally immature patients with unstable OCD lesions (Ewing and Voto stages: 9 stage II, 11 stage III, and 6 stage IV) treated with internal fixation. The methods of fixation varied based on the stage of the lesion and included the use of pitch screws (n = 11), bioabsorbable tacks (n = 10), partially threaded cannulated screws (n = 3), and bioabsorbable pins (n = 3). The authors reported no statically significant differences in the healing rate by lesion location, type of fixation, and patients with prior surgery. In addition, lesion stage did not statistically significantly influence the healing rate, Lysholm scores, International Knee Documentation Committee scores, or Tegner activity scores (See Table 28 and Table 29).

Please note the prognostic studies cannot be used as supporting evidence for a recommendation if it did not investigate the results of the effect of the treatment and/or the population of interest for the recommendation. The work group specified that the recommendations throughout this guideline are intended to be mutually exclusive.

SUMMARY OF PROGNOSTIC EVIDENCE

Table 26 Summary of prognostic evidence

Author	LOE	n	Outcome	Lesion location	Lesion stage	Fixation type	Prior surgery
Kocher 2007	V	24	Healing	○	○	○	○
	V	24	Lysholm score	-	○	-	-
	V	24	IKDC score	-	○	-	-
	V	24	Tegner score	-	○	-	-

Lesion location: Medial femoral condyle; lateral femoral condyle; patella; Lesion stage determined by Ewing and Voto; Fixation type: screws, tacks or pins; ●Statistically significant predictor; ○ not a statistically significant predictor; - predictor not addressed by the study

PROGNOSTIC STUDY QUALITY

Table 27 Study quality for prognostic study - Recommendation 3

Author	Kocher 2007
Level of Evidence	V
N	24
Prognostic Factor(s):	Fixation type, lesion stage, previous surgery
Quality Questions:	
Prospective	○
At Least 10 Patients per Important Variable	○
At Least 10 Events	n/a
All Important Variables Screened for Model	○
Interactions Tested	○
Collinearity Absent	○
Primary Analysis (not subgroup or post hoc)	●
Statistically Significant Fit	○
Article and Abstract Agree	●
Results Reported for All Studied Variables	○
Blinded Data Analysts	○

● = Yes ○ = No n/a = Not applicable

PROGNOSTIC STUDY RESULTS

Table 28 Prognostic factors and healing rates - Recommendation 3

Author	n	Factor		Healing Rate	p-value[1]	Power
Kocher 2007	24	Lesion Stage	Stage II	77.8% (7/9)	p = 0.810	Moderate
Kocher 2007	24		Stage III	81.8% (9/11)		
Kocher 2007	24		Stage IV	100% (6/6)		
Kocher 2007	24	Lesion Location	Medial femoral condyle	81.8% (18/22)	p = 0.785	Moderate
Kocher 2007	24		Lateral femoral condyle	100% (3/3)		
Kocher 2007	24		Patella	100% (1/1)		
Kocher 2007	24	Fixation type	Variable pitch screws	100% (11/11)	p = 0.450	Moderate
Kocher 2007	24		Partially threaded cannulated screws	66.7 % (2/3)		
Kocher 2007	24		Bioabsorbable tacks	80% (8/10)		
Kocher 2007	24		Bioabsorbable pins	66.7% (2/3)		
Kocher 2007	24	Prior Surgery[2]	Prior surgery	71.4 % (5/7)	p = 0.065	Moderate
Kocher 2007	24		No prior surgery	89.5 (17/19)		

[1]ANOVA: analysis of variance; [2] Student t test

Table 29 Lesion stage by outcome - Recommendation 3

Author	n	Outcome[1]	Lesion Stage			p- value	Power
			Stage II	Stage III	Stage IV		
Kocher 2007	24	Lysholm score	87.9	79.4	94.7	p = 0.895	Moderate
Kocher 2007	24	IKDC score[2]	84.1	78.5	87.8	p = 0.867	
Kocher 2007	24	Tegner activity score	70.0	72.0	83.0	p = 0.884	

[1] Values expressed as means, range 0-100; International Knee Documentation Committee

EXCLUDED PROGNOSTIC STUDIES

Table 30 Excluded prognostic studies – Recommendation 3

Author	Title	Reason for Exclusion
Kivisto 2002	Arthroscopic repair of osteochondritis dissecans of the femoral condyles with metal staple fixation: a report of 28 cases	Combines the results of skeletally immature patients and skeletally mature patients
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Combines the results of skeletally immature patients and skeletally mature patients and the results of multiple treatments
Mitsuoka 1999	Osteochondritis dissecans of the lateral femoral condyle of the knee joint	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients per group

RECOMMENDATION 4

Symptomatic skeletally mature patients with unstable or displaced OCD lesions be offered the option of surgery.

Strength of Recommendation: Limited

Rationale

Skeletally mature patients with OCD lesions who have a history of not healing and/or have signs of loosening (usually detected by MRI) are unlikely to heal without treatment. Further, these skeletally mature patients, because of loss of bone and cartilage, may be at higher risk of developing severe osteoarthritis (osteoarthrosis) at an early age. Although the exact degree of risk is not known, the work group deemed that it was imprudent to ignore it.

In issuing this consensus recommendation, the work group is issuing a recommendation consistent with current medical practice. However, the work group also acknowledges the paucity of evidence on the effectiveness of fixation of unstable OCD lesions, and that surgery entails risks. These risks include, but are not limited to, bleeding, infection, damage to nerves and blood vessels, venous thromboembolic events, anesthesia complications, and surgical failure. Again, however, not performing surgery also carries a risk, irreversible osteoarthritis/osteoarthrosis. This latter risk is of particular concern since effective treatments for young patients with severe osteoarthritis (osteoarthrosis) are limited. It is, therefore, the opinion of the work group that symptomatic patients with salvageable unstable or displaced OCD lesions (the work group defines “salvageable, unstable or displaced OCD lesions”, either unstable but in situ or displaced, as those that may be restored, using the patient’s native tissue from the osteochondritis region) be given the option of balancing the risks of performing or not performing surgery against the benefits of performing or not performing it. One potential benefit of surgery is the prevention or delay of severe osteoarthritis (osteoarthrosis). Another potential benefit is that these patients will be relieved of their existing symptoms.

The work group stresses that the choice to proceed with surgery is part of a shared decision making process between the patient, family, and physician. Offering patients the option of surgery is not a mandate that they have it. Patients can, and sometimes do, decline surgery.

Offering patients surgery requires informed consent. Failure to inform patients concerning the possible risks of surgical treatment is unethical and precludes them from surgery. Informed consent should provide patients with enough information about surgery to make a sound judgment about whether they wish to proceed to surgery given their individual situation.

The present recommendation does not apply to all patients with OCD. In many skeletal immature children (i.e., those with open physes), these lesions heal without treatment. This is particularly true in children who have incidentally discovered lesions and minimal symptoms. Accordingly, the work group makes no recommendations about surgery or physical therapy for such patients.

Supporting Evidence

One Level IV study[43] (See Table 46) (n = 15) reported the Tegner activity, Lysholm, Knee Outcome and Osteoarthritis Symptom and Sport (KOOS) and the SF-12 Mental and Physical scores of patients treated with arthroscopic reduction and internal fixation (ARIF). At 48 months, patients treated with ARIF had statistically significantly improvements from baseline measured by the Lysholm, International Knee Documentation Committee, Short form-12 (SF-12) Physical, and Knee injury and Osteoarthritis Outcome (KOOS) scores (See Table 47-Table 51). The authors reported no statistically significant improvements measured by the Tegner activity and the SF-12 mental outcome scores at 48 months (See Table 51). Twenty percent of patients treated with arthroscopic internal fixation required secondary surgical procedures (See Table 52).

SUMMARY OF RESULTS

Table 43 Tegner, Lysholm and IKDC scores - Arthroscopic reduction and internal fixation

Study	n	LOE	Outcome	Duration (months)	Significant improvement from baseline	Power
Pascual-Garrido 2009	15	IV	Tegner activity score	48	○	Low
Pascual-Garrido 2009	15	IV	Lysholm score	48	●	Low
Pascual-Garrido 2009	15	IV	IKDC score	48	●	Low

LOE: level of evidence; IKDC: International Knee Documentation Committee Score; ○ no statistically significant difference; ● statistically significant difference

Table 44 Knee Injury and Osteoarthritis Outcome Score - Arthroscopic reduction and internal fixation

Study	n	LOE	Outcome	Duration (months)	Significant improvement from baseline	Power
Pascual-Garrido 2009	15	IV	Pain	48	●	Low
Pascual-Garrido 2009	15	IV	Symptoms	48	●	Low
Pascual-Garrido 2009	15	IV	ADL	48	●	Low
Pascual-Garrido 2009	15	IV	Sport	48	●	Low
Pascual-Garrido 2009	15	IV	QOL	48	●	Low

LOE: level of evidence; ○ no statistically significant difference; ● statistically significant difference

Table 45 SF-12 Mental and Physical scores - Arthroscopic reduction and internal fixation

Study	n	LOE	Outcome	Duration (months)	Significant improvement from baseline	Power
Pascual-Garrido 2009	15	IV	SF-12-Mental	48	○	Low
Pascual-Garrido 2009	15	IV	SF-12-Physical	48	●	Low

LOE: level of evidence; ○no statistically significant difference; ● statistically significant difference

STUDY QUALITY
Table 46 Quality of case series studies

● = Yes ○ = No × = Not Reported
n/a = not applicable

Author	Outcome	n	Treatment	Level of Evidence	Consecutive enrollment of patients	Follow Up - 80% or more	All patients evaluated using same outcome measures	All patients receive same treatment	All pateints have approximately equal follow-up times
Pacual-Garrido 2009	Tegner	15	Arthroscopic reduction, internal fixation	Level IV	●	●	●	●	●
Pacual-Garrido 2009	Lysholm	15	Arthroscopic reduction, internal fixation	Level IV	●	●	●	●	●
Pacual-Garrido 2009	IKDC	15	Arthroscopic reduction, internal fixation	Level IV	●	●	●	●	●
Pacual-Garrido 2009	KOOS - Pain	15	Arthroscopic reduction, internal fixation	Level IV	●	●	●	●	●
Pacual-Garrido 2009	KOOS - Symptoms	15	Arthroscopic reduction, internal fixation	Level IV	●	●	●	●	●
Pacual-Garrido 2009	KOOS - ADL	15	Arthroscopic reduction, internal fixation	Level IV	●	●	●	●	●
Pacual-Garrido 2009	KOOS - Sport	15	Arthroscopic reduction, internal fixation	Level IV	●	●	●	●	●
Pacual-Garrido 2009	KOOS - QOL	15	Arthroscopic reduction, internal fixation	Level IV	●	●	●	●	●
Pacual-Garrido 2009	SF-12 Mental	15	Arthroscopic reduction, internal fixation	Level IV	●	●	●	●	●
Pacual-Garrido 2009	SF-12 Physical	15	Arthroscopic reduction, internal fixation	Level IV	●	●	●	●	●

IKDC: International Knee Documentation Committee Score; International Cartilage Repair Society Score; KSS: Knee Society Score; VAS: Visual Analog Scale; KOOS: Knee Injury and Osteoarthritis Outcome Score

STUDY RESULTS

Table 47 Tegner activity scores - Arthroscopic reduction and internal fixation

Author	n	LOE	Duration (months)	Results*	p- value
Pascual-Garrido 2009	15	IV	pre-op	2	p = 0.430
Pascual-Garrido 2009	15	IV	48	3	

*Values presented as mean values

Table 48 Lysholm scores - Arthroscopic reduction and internal fixation

Author	n	LOE	Duration (months)	Results*	p- value
Pascual-Garrido 2009	15	IV	pre-op	28	p = 0.008
Pascual-Garrido 2009	15	IV	48	42	

*Values presented as mean values

Table 49 IKDC scores - Arthroscopic reduction and internal fixation

Author	n	LOE	Duration (months)	Results*	p- value
Pascual-Garrido 2009	15	IV	pre-op	37	p = 0.005
Pascual-Garrido 2009	15	IV	48	53	

*Values presented as mean values

Table 50 KOOS scores - Arthroscopic reduction and internal fixation

Author	n	LOE	Duration (months)	Outcome	Results*	p- value
Pascual-Garrido 2009	15	IV	pre-op	Pain	65	p = 0.007

Author	n	LOE	Duration (months)	Outcome	Results*	p- value
Pascual-Garrido 2009	15	IV	48	Pain	81	p = 0.007
Pascual-Garrido 2009	15	IV	pre-op	Symptoms	54	p = <0.001
Pascual-Garrido 2009	15	IV	48		80	
Pascual-Garrido 2009	15	IV	pre-op	ADL	72	p = <0.001
Pascual-Garrido 2009	15	IV	48		86	
Pascual-Garrido 2009	15	IV	pre-op	Sport	29	p = 0.028
Pascual-Garrido 2009	15	IV	48		80	
Pascual-Garrido 2009	15	IV	pre-op	QOL	25	p = 0.134
Pascual-Garrido 2009	15	IV	48		53	

*Values presented as mean values

Table 51 SF-12 - Arthroscopic reduction and internal fixation

Author	n	LOE	Duration (months)	Outcome	Results*	p- value
Pascual-Garrido 2009	15	IV	pre-op	Mental	53	p = 0.134
Pascual-Garrido 2009	15	IV	48		56	p = 0.134
Pascual-Garrido 2009	15	IV	pre-op	Physical	36	p = 0.002
Pascual-Garrido 2009	15	IV	48		41	

*Values presented as mean values

Table 52 Secondary surgical procedures - Arthroscopic reduction and internal fixation

Author	n	LOE	Duration (months)	Outcome	Results	p- value
Pascual-Garrido 2009	15	IV	48	Secondary Surgical Procedures	20% (3/15)	Nr

EXCLUDED STUDIES

Table 53 Excluded studies

Author	Title	Reason for Exclusion
Magnussen 2009	Does operative fixation of an osteochondritis dissecans loose body result in healing and long-term maintenance of knee function?	Combines the results of skeletally immature patients and skeletally mature patients
Gomoll 2007	Internal fixation of unstable Cahill Type-2C osteochondritis dissecans lesions of the knee in adolescent patients	Combines the results of skeletally immature and skeletally mature patients/ No baseline data reported
Weckstrom 2007	Comparison of bioabsorbable pins and nails in the fixation of adult osteochondritis dissecans fragments of the knee: an outcome of 30 knees	Retrospective case series
Gudas 2006	Osteochondral autologous transplantation versus microfracture for the treatment of articular cartilage defects in the knee joint in athletes	Not specific to OCD
Kouzelis 2006	Herbert screw fixation and reverse guided drillings, for treatment of types III and IV osteochondritis dissecans	Combines the results of multiple Tx's - confounding results
Gudas 2005	A prospective randomized clinical study of mosaic osteochondral autologous transplantation versus microfracture for the treatment of osteochondral defects in the knee joint in young athletes	Less than 80% OCD
Makino 2005	Arthroscopic fixation of osteochondritis dissecans of the knee: clinical, magnetic resonance imaging, and arthroscopic follow-up	Combines the results of skeletally immature patients and skeletally mature patients
Bramer 2004	Increased external tibial torsion and osteochondritis dissecans of the knee	No baseline data
Jurgensen 2002	Arthroscopic versus conservative treatment of osteochondritis dissecans of the knee: value of magnetic resonance imaging in therapy planning and follow-up	Combines the results of skeletally immature patients and skeletally mature patients
Kivisto 2002	Arthroscopic repair of osteochondritis dissecans of the femoral condyles with metal staple fixation: a report of 28 cases	Combines the results of skeletally immature patients and skeletally mature patients/Retrospective case series
Jaberi 2002	Osteochondritis dissecans of the weight-bearing surface of the medial femoral condyle in adults	Retrospective case series
Navarro 2002	The arthroscopic treatment of osteochondritis dissecans of the knee with autologous bone sticks	Less than 10 patients per group/Retrospective case series

Table 53 Excluded studies

Author	Title	Reason for Exclusion
Aglietti 2001	Results of arthroscopic excision of the fragment in the treatment of osteochondritis dissecans of the knee	Retrospective case series
Zmerly 2000	The treatment of cartilage injuries in footballers	Combines the results of skeletally immature patients and skeletally mature patients
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Combines the results of skeletally immature patients and skeletally mature patients and the results of multiple treatments
Mitsuoka 1999	Osteochondritis dissecans of the lateral femoral condyle of the knee joint	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients per group
Hangody 1998	Mosaicplasty for the treatment of osteochondritis dissecans of the knee	No baseline data reported
Schneider 1998	The value of magnetic resonance imaging as postoperative control after arthroscopic treatment of osteochondritis dissecans	Retrospective case series
Aglietti 1997	Osteochondritis dissecans of the knee: Medium-term results of arthroscopic removal of the fragment	Retrospective case series
De Smet 1997	Untreated osteochondritis dissecans of the femoral condyles: prediction of patient outcome using radiographic and MR findings	Combines the results of skeletally immature patients and skeletally mature patients/ Less than 10 pts
Havulinna 1995	Long-term results of Smillie pin fixation of osteochondritis dissecans in the femoral condyles	Retrospective case series
Cugat 1993	Osteochondritis dissecans: A historical review and its treatment with cannulated screws	Combines the results of skeletally immature patients and skeletally mature patients
Johnson 1990	Osteochondritis dissecans of the knee: arthroscopic compression screw fixation	Combines the results of multiple treatments
Jakob 1989	A compression pinning system for osteochondritis dissecans of the knee	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients
Ewing 1988	Arthroscopic surgical management of osteochondritis dissecans of the knee	Retrospective case series
Schwarz 1988	The results of operative treatment of osteochondritis dissecans of the patella	No baseline data
Desai 1987	Osteochondritis dissecans of the patella	Less than 10 patients per group

Table 53 Excluded studies

Author	Title	Reason for Exclusion
Denoncourt 1986	Arthroscopy update #1. Treatment of osteochondrosis dissecans of the knee by arthroscopic curettage, follow-up study	Surgical technique not relevant
Hughston 1984	Osteochondritis dissecans of the femoral condyles	Combines the results of skeletally immature patients and skeletally mature patients
Guhl 1982	Arthroscopic treatment of osteochondritis dissecans	Less than 10 patients per group
Gillespie 1979	Bone peg fixation in the treatment of osteochondritis dissecans of the knee joint	Retrospective case series/Combines the results of skeletally immature patients and skeletally mature patients
Lindholm 1979	Treatment of juvenile osteochondritis dissecans in the knee	Combines the results of skeletally immature patients and skeletally mature patients
Lindholm 1974	Osteochondritis dissecans of the knee. A clinical study	Combines the results of skeletally immature patients and skeletally mature patients
Langer 1971	Osteochondritis dissecans and anomalous centres of ossification: a review of 80 lesions in 61 patients	Retrospective case series/Combines the results of skeletally immature patients and skeletally mature patients
Aichroth 1971	Osteochondritis dissecans of the knee. A clinical survey	Less than 10 patients per Tx group

PROGNOSTIC EVIDENCE

Two Level IV studies[43, 57], (n = 59) reported the results of skeletally mature patients with OCD lesions treated by internal fixation or allograft and any associations between the patient's age, lesion severity and size with final clinical outcome results. One study [47] included only male patients that were actively involved in the military. These patients had either stable (Guhl: I and II) or unstable (Guhl: III and IV) OCD lesions and were treated with either bioabsorbable pins or nails. The second study [46] enrolled patients with unstable OCD lesions and compared the results of patients treated with fixation with plates and screws to patients treated with allograft. One study [47] reported a statistically significant positive association between the lesion size and the appearance of sclerosis (See Table 55). Both studies reported no other statistically significant associations between the remaining factors analyzed with the final outcomes (See Table 55).

PROGNOSTIC STUDY QUALITY
Table 54 Prognostic study quality

Author	Pascual - Garrido 2009	Weckstrom 2007
Level of Evidence	IV	IV
N	31	28
Prognostic Factor(s):	age, defect size	lesion size and severity, fragment size
Quality Questions:		
Prospective	○	●
At Least 10 Patients per Important Variable	●	○
At Least 10 Events	n/a	n/a
All Important Variables Screened for Model	○	○
Interactions Tested	●	○
Collinearity Absent	○	○
Primary Analysis (not subgroup or post hoc)	○	●
Statistically Significant Fit	○	○
Article and Abstract Agree	●	●
Results Reported for All Studied Variables	●	●
Blinded Data Analysts	n/a	n/a

● = Yes ○ = No n/a= Not applicable

Table 55 Prognostic study results

Author	LOE	n	Outcome	Duration (months)	Age	p - value	Lesion Size	p - value	Lesion Severity	p-value
Pascual - Garrido 2009	IV	31	Lysholm score[1]	48	*r* = 0.0	p = 0.882	*r* = -0.07	p = 0.59	-	-
Weckstrom 2007	IV	28	Kujala score[1]	43	-	-	nr	p = 0.98	nr	p = 0.3
			Pain (VAS)[2]		-	-	nr	p = 0.35	nr	p = 0.2
			Sclerosis		-	-	*r* = 0.63	nr	-	-

[1] Lysholm score and Kujala score: range: 0-100; Pain (VAS): range 0-10; *r*: Pearson correlation coefficient; - Study did not analyze prognostic factor; nr: not reported

EXCLUDED PROGNOSTIC STUDIES

Table 56 Excluded prognostic studies

Author	Title	Reason for Exclusion
Steinhagen 2009	Treatment of osteochondritis dissecans of the femoral condyle with autologous bone grafts and matrix-supported autologous chondrocytes	not best available evidence
Braun 2008	The 5.5-year results of MegaOATS--autologous transfer of the posterior femoral condyle: a case-series study	Prognostic results are not relevant to OCD
Ossendorf 2007	Autologous chondrocyte implantation for the treatment of large full-thickness cartilage lesions of the knee	Less than 80% with OCD
Kouzelis 2006	Herbert screw fixation and reverse guided drillings, for treatment of types III and IV osteochondritis dissecans	nsufficient quantitative data for prognostics
Krishnan 2006	Collagen-covered autologous chondrocyte implantation for osteochondritis dissecans of the knee: two- to seven-year results	Combines the results of skeletally immature patients and skeletally mature patients/ Less than 10 skeletally mature patients
Sharpe 2005	The treatment of osteochondral lesions using a combination of autologous chondrocyte implantation and autograft: three-year follow-up	not best available evidence
Wright 2004	Osteochondritis dissecans of the knee: long-term results of excision of the fragment	Insufficient quantitative data for prognostics
Peterson 2003	Treatment of osteochondritis dissecans of the knee with autologous chondrocyte transplantation: results at two to ten years	Insufficient quantitative data for prognostics
Jaberi 2002	Osteochondritis dissecans of the weight-bearing surface of the medial femoral condyle in adults	Insufficient quantitative data for prognostics
Kivisto 2002	Arthroscopic repair of osteochondritis dissecans of the femoral condyles with metal staple fixation: a report of 28 cases	Combines the results of skeletally immature patients and skeletally mature patients
Aglietti 2001	Results of arthroscopic excision of the fragment in the treatment of osteochondritis dissecans of the knee	not best available evidence
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Combines the results of skeletally immature patients and skeletally mature patients

Author	Title	Reason for Exclusion
Mitsuoka 1999	Osteochondritis dissecans of the lateral femoral condyle of the knee joint	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients per group
Anderson 1997	Osteochondritis dissecans of the femoral condyles. Long-term results of excision of the fragment	Insufficient quantitative data for prognostics
Havulinna 1995	Long-term results of Smillie pin fixation of osteochondritis dissecans in the femoral condyles	Not best available evidence
Anderson 1990	Antegrade curettement, bone grafting and pinning of osteochondritis dissecans in the skeletally mature knee	not best available evidence
Ewing 1988	Arthroscopic surgical management of osteochondritis dissecans of the knee	Insufficient data for prognostic factors

RECOMMENDATION 5

In the absence of reliable evidence, it is the opinion of the work group that patients who remain symptomatic after treatment for OCD have a history and physical examination, x-rays and/or MRI to assess healing.

Strength of Recommendation: Consensus

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

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

Rationale

We suspect that patients with OCD have risk of developing severe osteoarthritis (osteoarthrosis) at a young age. The treatment options for these young patients with osteoarthritis (osteoarthrosis) are limited and therefore, their quality of life is significantly impacted. Based on this premise, the work group issued a consensus recommendation despite the lack of evidence to support or refute the use of ongoing evaluation in patients with a diagnosis of OCD.

In patients with OCD that remain symptomatic despite previous treatment, ongoing evaluation with a goal to preserve the patient's knee function and native cartilage is a priority. The evaluation is based upon the patient's symptoms, signs, and imaging to detect possible deterioration. Recognition and intervention allowing treatment of lesions at early stages may improve outcomes and prevent sequelae (e.g. severe osteoarthritis (osteoarthrosis)) associated with later stages of disease. Although lesion stability may not be assessed with a high level of confidence on imaging studies, the progression or worsening of the condition can be evaluated by comparing sequential imaging studies. The work group acknowledges that radiographic studies expose the patient to radiation. We are also aware of the increased costs of imaging studies. We believe that the practice of ongoing history, physical, and imaging studies is consistent with the current practice of most orthopaedic surgeons.

Supporting Evidence

There is no evidence to address this recommendation.

RECOMMENDATION 6

In the absence of reliable evidence, it is the opinion of the work group that patients who have received surgical treatment of OCD be offered the option of post-operative physical therapy.

Strength of Recommendation: Consensus

> Description: The supporting evidence is lacking and requires the work group to make a recommendation based on expert opinion by considering the known potential harm and benefits associated with the treatment. A **Consensus** recommendation means that expert opinion supports the guideline recommendation even though there is no available empirical evidence that meets the inclusion criteria of the guideline's systematic review.
>
> Implications: Practitioners should be flexible in deciding whether to follow a recommendation classified as **Consensus,** although they may give it preference over alternatives. Patient preference should have a substantial influencing role.

Rationale

Patients who receive surgical interventions for OCD of the knee may experience impairments such as loss of motion, strength deficits, altered movement patterns, and post-operative effusion. Although we could not locate any rigorously collected evidence about how common these impairments are, or their degree of severity, the work group deemed that it was imprudent to ignore them.

In making this consensus recommendation, the work group is issuing a recommendation consistent with current practice. However, the work group also acknowledges the paucity of evidence on the effectiveness of physical therapy, including its effects on either the duration or severity of these impairments (none of the eight studies included in this guideline that reported that their patients received post-operative physical therapy.[42, 44-46, 51, 52, 56, 57] evaluated the effects of that therapy), or whether supervised therapy and unsupervised therapy yield different outcomes. Accordingly, it is not possible to determine whether patients should be offered supervised or unsupervised therapy.

The work group also notes that there are minimal risks associated with physical therapy, which, given its potential benefits, also argues for offering it to patients. These patients should be offered sufficient information to allow them to choose between supervised and unsupervised therapy, given their own, unique circumstances.

Supporting Evidence

There is no evidence to address this recommendation.

FUTURE RESEARCH

Although osteochondritis dissecans (OCD) was identified over a century ago, the natural history of OCD of the knee remains unclear and appropriate treatment is largely unknown. There is a paucity of high quality diagnostic, prognostic, and therapeutic studies that reported data separately for adults and children. In fact, only 16 studies of OCD were of sufficient quality to be included in this clinical practice guideline.

Some specific trials that would meaningfully assist in the development of future guidelines follow:

1. Inter- and intra-observer reliability studies should be conducted on critical observations used in diagnosing and characterizing OCD lesions. These critical observations include the radiographic (x-ray and MRI) and arthroscopic assessment of OCD lesion size, location, and stability. These reliability studies are essential to ensure that the reference standards are reproducible before their predictive value is assessed.

2. Prospective cohort studies of knee OCD lesions treated non-operatively should be conducted to identify the independent predictors of success of non-operative management of an OCD lesion. These independent predictors may be historical information (e.g., age, mechanical symptoms), physical examination findings (e.g., effusion, point tenderness), or radiographic features (e.g., distal femur skeletal maturity, lesion size, lesion stability). Such a study would allow for more precise prognostication and more exact surgical indications.

3. Randomized controlled trials should be conducted to establish the optimal physical therapy and non-operative treatment strategies and physical therapy interventions for patients with OCD of the knee. Important variables such as the efficacy of immobilization, optimal periods of restricted weight bearing, and the utility of specific physical therapy interventions need to be investigated in skeletally immature patients with stable lesions. For example, patients with stable lesions that are predicted to heal, therapy and exercise modalities specific physical therapy interventions could be compared to determine their impact on the healing process. These trials would also identify patient characteristics that predict healing potential or failure of healing during the course of these specific non-operative treatments.

4. Randomized controlled trials should be conducted to establish the optimal surgical treatment strategies for OCD of the knee. For example, patients with stable lesions that are predicted to fail non-operative treatment may be studied utilizing a randomized study design comparing anterograde to retrograde drilling. Alternatively, patients with unstable lesions may be studied utilizing a randomized study design comparing fixation with mini-fragment screws to fixation with variable pitch screws to fixation with bioabsorbable pins. Finally, patients with OCD lesions that are not salvageable may be randomized to fresh osteochondral allograft or autologous chondrocyte implantation.

5. Randomized controlled trials should be conducted to determine the optimal post-operative management of patients with OCD of the knee. These investigations need to include management of drilling procedures, fixation procedures and cartilage restoration

procedures, with a focus on length of immobilization, length of restricted weight bearing, timing of onset of rehabilitation and the efficacy of specific targeted physical therapy interventions.

6. The available classification systems should be reviewed, compare, evaluated and validated according to the most important criteria for the diagnosis of Osteochondritis Dissecans. Identifying a reliable classification system could help standardize diagnoses, corresponding treatment and the true incidence and prevalence of this disease in children and adults.

Since OCD is a rare condition, many of these trials will need to be designed and conducted as multicenter studies. Multicenter studies allow for faster enrollment of an adequate sample size. In addition, a multicenter design may improve external validity.

IV. APPENDICES

APPENDIX I: WORK GROUP

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APPENDIX II
AAOS BODIES THAT APPROVED THIS CLINICAL PRACTICE GUIDELINE

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

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

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

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

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

DOCUMENTATION OF APPROVAL

AAOS Work Group Draft Completed	April 11, 2010

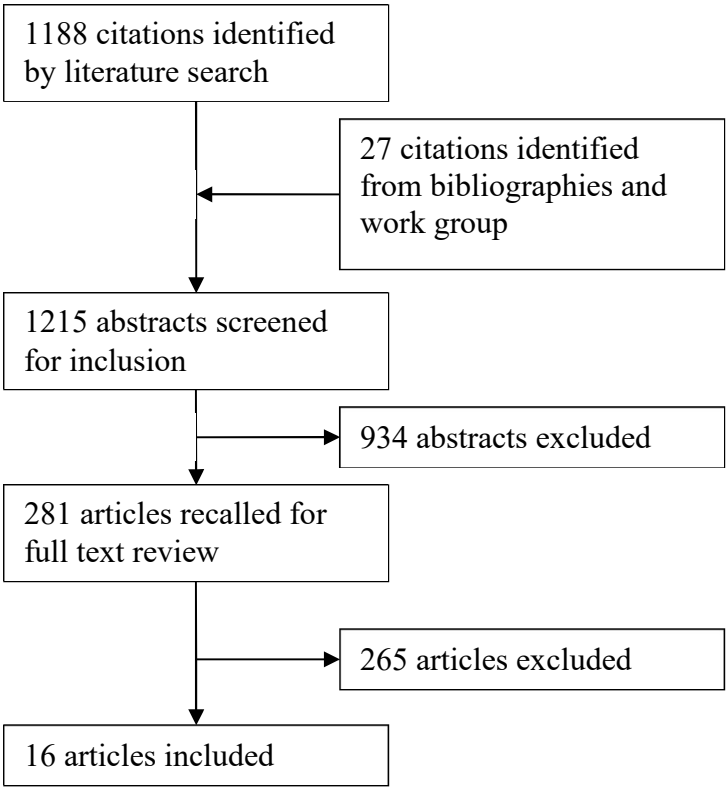
Review Process

Peer Review Completed	June 18, 2010
Public Commentary Completed	November 12, 2010

Approval Process

AAOS Guidelines and Technology Oversight Committee	November 18, 2010
AAOS Evidence Based Practice Committee	November 18, 2010
AAOS Council on Research Quality Assessment and Technology	November 19, 2010
AAOS Board of Directors	***December 04, 2010***

APPENDIX III
STUDY ATTRITION FLOWCHART



APPENDIX IV
LITERATURE SEARCHES

Search Strategy for PubMed

("Osteochondritis Dissecans"[mh] OR (osteochondr*[tiab] AND (dissecans[tiab] OR defect[tiab] OR lesion*[tiab]))) AND ("Knee Joint"[mh] OR "Knee"[Mesh] OR "Osteoarthritis, Knee"[mh] OR knee[tiab] OR knees[tiab] OR "Menisci, Tibial"[mh] OR menisc*[tiab] OR Femur[mh] OR femur[tiab] OR femoral[tiab] OR Tibia[mh] OR tibia*[tiab] OR Patella[mh] OR patella*[tiab])

Limiters applied to search:

English[lang] NOT ((animal[mh] NOT human[mh]) OR cadaver[mh] OR "in vitro"[pt] OR comment[pt] OR editorial[pt] OR letter[pt] OR addresses[pt] OR news[pt] OR "newspaper article"[pt] OR “historical article”[pt] OR “case report”[title])

Sorted by study type:

#1 Systematic Reviews:
(Medline[tw] OR systematic review[tiab] OR meta-analysis[pt])

#2Clinical Trials:
(("Clinical Trial"[pt] OR (clinical[tiab] AND trial[tiab]) OR random*[tw] OR "therapeutic use"[sh]) NOT #1)

#3 Other Studies:
NOT (#1 OR #2)

Search Strategy for EMBASE

("Osteochondritis Dissecans"[mh] OR (osteochondr*[tiab] AND (dissecans[tiab] OR defect[tiab] OR lesion*[tiab]))) AND ("Knee Joint"[mh] OR "Knee"[Mesh] OR "Osteoarthritis, Knee"[mh] OR knee[tiab] OR knees[tiab] OR "Menisci, Tibial"[mh] OR menisc*[tiab] OR Femur[mh] OR femur[tiab] OR femoral[tiab] OR Tibia[mh] OR tibia*[tiab] OR Patella[mh] OR patella*[tiab])

Limiters applied to search:

AND [english]/lim AND [humans]/lim AND [embase]/lim NOT (cadaver/de OR 'in vitro study'/exp OR ‘case report’:ti OR 'abstract report'/de OR book/de OR editorial/de OR letter/de OR note/de)

Sorted by study type:

#1 Systematic Reviews:
(Medline[tw] OR systematic review[tiab] OR meta-analysis[pt])

#2 Clinical Trials:
(("Clinical Trial"[pt] OR (clinical[tiab] AND trial[tiab]) OR random*[tw] OR "therapeutic use"[sh]) NOT #1)

#3 Other Studies:
NOT (#1 OR #2)

Search Strategy for CIn/aHL

(MH " Osteochondritis Dissecans" or (osteochondr* and (dissecans or defect* or lesion*))) and (MH "knee" or MH "knee joint" or MH "Osteoarthritis, Knee" or knee or knees or MH "Menisci, Tibial" or menisci* or MH "femur" or femur or femoral or MH "tibia" or tibia* or MH "patella" or patella*)

and LA English

not (PT "editorial" or PT "letter" or PT "case study" or TI "case report")

Sorted by study type:

#1 Systematic Reviews:
and ("meta analysis" or PT "review" or PT "systematic review")

#2 Clinical Trials:
and ((MH "treatment outcomes+" OR MH "experimental studies" OR random*) not #1)

Other Studies:
NOT (#1 OR #2)

Search Strategy for Cochrane Library

(osteochondr* AND (dissecans or defect or lesion*)) AND (knee* OR femur OR femoral OR menisci* OR tibia* OR patella*)

APPENDIX V
DATA EXTRACTION ELEMENTS

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

Study Characteristics

- methods of randomization and allocation
- blinding of patients and evaluators
- loss to follow-up
- study design

Patient Characteristics

- patient inclusion/exclusion criteria
- age
- gender
- lesion classification

Results (for all relevant outcomes in a study)

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

APPENDIX VI
JUDGING THE QUALITY OF DIAGNOSTIC STUDIES

The QUADAS tool [30, 59, 60] is used to identify sources of bias, variability, and the quality of reporting in studies of diagnostic accuracy. Fourteen questions answered "yes", "no", or "unclear" contribute to the QUADAS tool. There is no score derived from the use of the QUADAS tool.

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

Were selection criteria clearly described?

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

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

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

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

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

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

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

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

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

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

Were uninterpretable/intermediate test results reported?

Were withdrawals from the study explained?

JUDGING THE QUALITY OF TREATMENT STUDIES

RANDOMIZED CONTROLLED TRIALS

Did the study employ stochastic randomization?

Was there concealment of allocation?

Were subjects blinded to the treatment they received?

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

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

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

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

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

PROSPECTIVE NON- RANDOMIZED CONTROLLED STUDIES

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

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

Were all of the study's groups concurrently treated?

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

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

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

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

RETROSPECTIVE COMPARATIVE STUDIES

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

Were all of the study's groups concurrently treated?

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

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

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

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

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

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

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

CASE SERIES

Was enrollment in the study consecutive?

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

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

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

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

JUDGING THE QUALITY OF PROGNOSTIC STUDIES

Was the study prospective?

Were there 10 or more patients for every independent variable in the final model?

Is the outcome variable dichotomous? If yes, were there 10 or more events and 10 or more "non-events" for each variable in the final model?

Did the article's "Methods" section indicate that all important variables were screened for entry into the final model?

Were statistical interactions tested for?

Was there either; (a) limited potential for collinearity or, (b) a demonstration that collinearity is not present?

Was the analysis a primary analysis that was NOT a subgroup analysis?

Was the fit of the overall model statistically significant (answer "no" for univariate tests)?

Are the conclusions in the article's Abstract and "Discussion" sections free from contradiction with the data in the article's "Results" section?

Were results reported for all variables mentioned in the article's "Methods" section (and/or the study protocol)?

Did the study involve determining which patient type(s) respond best to a treatment?

OPINION-BASED RECOMMENDATIONS

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

Opinion-based recommendations are developed only if they address a vitally important aspect of patient care. For example, constructing an opinion-based recommendation in favor of taking a history and physical is warranted. Constructing an opinion-based recommendation in favor of a specific modification of a surgical technique is seldom warranted. To ensure that an opinion-based recommendation is absolutely necessary, the AAOS has adopted rules to guide the content of the rationales that underpin such recommendations. These rules are based on those outlined by the US Preventive Services Task Force (USPSTF).[61] Specifically, rationales based on expert opinion must:

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

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

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

- Address potential harms. In general, "When the evidence is insufficient, an intervention with a large potential for harm (such as major surgery) might be viewed less favorably than an intervention with a small potential for harm (such as advice to watch less television)."[61]

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

Information garnered from the previous bullet points will be helpful in this regard.

- Consider current practice. The USPSTF specifically states that clinicians justifiably fear that not doing something that is done on a widespread basis will lead to litigation.[61] The consequences of not providing a service that is neither widely available nor widely used are less serious than the consequences of not providing a treatment accepted by the medical profession and thus expected by patients. Discussions of available treatments and procedures rely on mutual communication between the patient's guardian and physician, and on weighing the potential risks and benefits for a given patient. The patient's "expectation of treatment" must be tempered by the treating physician's guidance about the reasonable outcomes that the patient can expect.

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

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

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

CHECKLIST FOR VOTING ON OPINION-BASED RECOMMENDATIONS

When voting on the rationale, please consider the following:

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

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

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

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

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

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

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

Appendix VII

FORM FOR ASSIGNING STRENGTH OF RECOMMENDATION (INTERVENTIONS)

GUIDELINE RECOMMENDATION_____

PRELIMIn/aRY STRENGTH OF RECOMMENDATION: _____

STEP 1: LIST BENEFITS AND HARMS

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

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

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

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

STEP 2: IDENTIFY CRITICAL OUTCOMES

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

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

What is the resulting strength of recommendation?

STEP 3: EVALUATE APPLICABILITY OF THE EVIDENCE

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

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

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

What is the resulting strength of recommendation?

STEP 4: BALANCE BENEFITS AND HARMS

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

What is the resulting strength of recommendation?

STEP 5 CONSIDER STRENGTH OF EVIDENCE

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

What is the resulting strength of recommendation?

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

APPENDIX VIII
VOTING BY THE NOMINAL GROUP TECHNIQUE

Voting on guideline recommendations will be conducted using a modification of the nominal group technique (NGT), a method previously used in guideline development.[35] Briefly each member of the guideline work group ranks his or her agreement with a guideline recommendation on a scale ranging from 1 to 9 (where 1 is "extremely inappropriate" and 9 is "extremely appropriate"). Consensus is obtained if the number of individuals who do not rate a measure as 7, 8, or 9 is statistically non-significant (as determined using the binomial distribution). Because the number of work group members who are allowed to dissent with the recommendation depends on statistical significance, the number of permissible dissenters varies with the size of the work group. The number of permissible dissenters for several work group sizes is given in the table below:

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

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

APPENDIX IX
STRUCTURED PEER REVIEW FORM

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

Reviewer Information:

Name of Reviewer_____

Address_____

City_____State_____Zip Code_____

Phone_____Fax_____E-mail_____

Specialty Area/Discipline: _____

Work setting:_____Credentials: _____

May we list you as a Peer Reviewer in the final Guidelines (GL)? ☐ Yes ☐ No
If you do not wish to be listed, your name will be removed for identification purposes. However, your COI will still be available for review with the comments you have made.

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

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

Society Name: _____
(Listing the specialty society as a reviewing society does not imply or otherwise indicate endorsement of this guideline.)

Conflicts of Interest (COI): All Reviewers must declare their conflicts of interest.

If the boxes below are not checked and/or the reviewer does not attach his/her conflicts of interest, the reviewer's comments will not be addressed by the AAOS nor will the reviewer's name or society be listed as a reviewer of this GL. If a committee reviews the guideline, only the chairperson/or lead of the review must declare their relevant COI.

☐ **I have declared my conflicts of interest on page 2 of this form.** ☐ **I have declared my conflicts of interest in the AAOS database; my customer # is _____**
☐ **I understand that the AAOS will post my declared conflicts of interest with my comments concerning review of this guideline or technology overview on the AAOS website.**

REVIEWER CONFLICT OF INTEREST - The Orthopaedic Disclosure Program

Each item below requires an answer. Please report information for the last 12-months as required by the Accreditation Council for Continuing Medical Education (ACCME) guidelines.

Do you or a member of your immediate family receive royalties for any pharmaceutical, biomaterial or orthopaedic product or device? If YES, please identify product or device:	☐ Yes ☐ No
Within the past twelve months, have you or a member of your immediate family served on the speakers bureau or have you been paid an honorarium to present by any pharmaceutical, biomaterial or orthopaedic product or device company? If YES, please identify company:	☐ Yes ☐ No
Are you or a member of your immediate family a PAID EMPLOYEE for any pharmaceutical, biomaterial or orthopaedic device or equipment company, or supplier? If YES, please identify company or supplier:	☐ Yes ☐ No
Are you or a member of your immediate family a PAID CONSULTANT for any pharmaceutical, biomaterial or orthopaedic device or equipment company, or supplier? If YES, please identify company or supplier:	☐ Yes ☐ No
Are you or a member of your immediate family an UNPAID CONSULTANT for any pharmaceutical, biomaterial or orthopaedic device or equipment company, or supplier? If YES, please identify company or supplier:	☐ Yes ☐ No
Do you or a member of your immediate family own stock or stock options in any pharmaceutical, biomaterial or orthopaedic device or equipment company, or supplier (excluding mutual funds) If YES, please identify company or supplier:	☐ Yes ☐ No
Do you or a member of your immediate family receive research or institutional support as a principal investigator from any pharmaceutical, biomaterial or orthopaedic device or equipment company, or supplier? If YES, please identify company or supplier:	☐ Yes ☐ No
Do you or a member of your immediate family receive any other financial or material support from any pharmaceutical, biomaterial or orthopaedic device and equipment company or supplier? If YES, please identify company or supplier:	☐ Yes ☐ No
Do you or a member of your immediate family receive any royalties, financial or material support from any medical and/or orthopaedic publishers? If YES, please identify publisher:	☐ Yes ☐ No
Do you or a member of your immediate family serve on the editorial or governing board of any medical and/or orthopaedic publication? If YES, please identify:	☐ Yes ☐ No
Do you or a member of your immediate family serve on the Board of Directors or a committee of any medical and/or orthopaedic professional society? If YES, please identify:	☐ Yes ☐ No

Reviewer Instructions

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

Please complete and return this form electronically to wies@aaos.org or fax the form back to Jan Wies at (847) 823-9769. Thank you in advance for your time in completing this form and giving us your feedback. We value your input and greatly appreciate your efforts. Please send the completed form and comments by end of day **DATE**.

Please indicate your level of agreement with each of the following statements by placing an "X" in the appropriate box.

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

COMMENTS

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

---

OVERALL ASSESSMENT

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

☐ Strongly recommend

☐ Recommend (with provisions or alterations)

☐ Would not recommend

☐ Unsure

APPENDIX X
PEER REVIEW

Participation in the AAOS peer review process does not constitute an endorsement of this guideline by the participating organization.

Peer review of the draft guideline is completed by an external Peer Review Panel, the AAOS Guidelines and Technology Oversight Committee and the AAOS Evidence Based Practice Committee. External peer reviewers are solicited for each AAOS guideline and consist of experts in the guideline's topic area. These experts represent professional societies other than AAOS and are nominated by the guideline work group prior to beginning work on the guideline. For this guideline, fourteen outside peer review organizations were invited to review the draft guideline and all supporting documentation. Four societies participated in the review of the Treatment of Osteochondritis Dissecans guideline draft and three explicitly consented to be listed as a peer review organization in this appendix. One organization did not give explicit consent that the organization name could be listed in this publication.

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

American College of Occupational and Environmental Medicine (ACOEM)
American Physical Therapy Association (APTA)

Pediatric Orthopaedic Society of North America (POSNA) Evidence Based Medicine Committee

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

Kurt T. Hegmann MD, MPH

Terese Chmielewski PT, PhD, SCS

Brian J. Ludwig MD

Jeffrey R. Dugas MD

Kishore Mulpuri MD, Chair POSNA EBM Committee

Charles Reitman MD

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

PUBLIC COMMENTARY

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

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

Brian Rill MD

Fred Nelson MD

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

APPENDIX XI
ABBREVIATIONS USED IN THIS GUIDELINE

Abbreviation	Corresponding definition
AAOS	American Academy of Orthopaedic Surgeons
ACL	Anterior Cruciate Ligament
ADL	Activities of daily living
AP	An X-ray picture in which the beams pass from front-to-back (anteroposterior)
ARIF	Arthroscopic reduction and internal fixation
BOC	AAOS Board of Councilors
BOD	AAOS Board of Directors
BOS	AAOS Board of Specialty Societies
CI	Confidence interval
95% CI	95% confidence interval
CINHL	Cumulative Index to Nursing and Allied Health Literature
CME	Continuing Medical Education
CORQAT	AAOS Council on Research, Quality Assessment, and Technology
EBM	Evidence- based medicine
EBPC	AAOS Evidence Based Practice Committee
EMBASE	Excerpta Medica Database
GRADE	Grading of Recommendations, Assessment, Development, and Evaluation
GTOC	AAOS Guidelines and Technology Oversight Committee
IKDC	International Knee Documentation Committee Score
KOOS	Knee Outcome and Osteoarthritis Symptom and Sport
LOE	Level of Evidence
LR	Liklihood Ratios
MCID	minimal clinically important difference
MCII	minimal clinically important improvement
MF	microfracture
MRI	magnetic resonance imaging
n/a	not applicable
NGC	National Guideline Clearinghouse
NGT	Nominal Group Technique
OAT	Osteochondral Autologous Transplantation
OCD	Osteochondritis Dissecans
OR	odds ratio
PubMed	PubMed®, the National Library of Medicine (NLM®) journal literature
QUADAS	Quality Assessment of Diagnostic Accuracy Studies instrument
SD	standard deviation
SF-12	12-Item Short Form Survey Instrument
SF-36	36-Item Short Form Survey Instrument
VAS	visual analog scale

APPENDIX XII
CONFLICT OF INTEREST

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

Allen F Anderson, MD: 3B (orthopediatrics); 7 (Am J Sports Med); 8 (Am J Sports Med); 9 (American Orthopaedic Society for Sports Medicine); Submitted on: 06/15/2010 and last confirmed as accurate on 10/05/2010.

Tommy J. (JoJo) Brunelle, PT DPT: (n). Submitted on: 03/04/2009 at 09:14 PM.

James L. Carey, MD: n) Submitted on: 04/24/2010 and last confirmed as accurate on 10/08/2010.

Henry G. Chambers, MD: 3B (Allergan Corporation); 8 (Gait and Posture); 9 (American Academy for Cerebral Palsy and Developmental Medicine; Pediatric Orthopaedic Society of North America); Submitted on: 09/29/2010.

Theodore J. Ganley, MD: 3B (OrthoPediatrics Corp); Submitted on: 03/11/2010 and last confirmed as accurate on 09/10/2010.

Mark Paterno, PT: (n) Submitted on: 04/09/2010 and last confirmed as accurate on 05/27/2010.

James O. Sanders, MD (Rochester, NY): 3C (Orthopediatrics); 4 (Abbott; Hospira); 5 (Medtronic Sofamor Danek); 9 (AAOS; American Orthopaedic Association; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America; Scoliosis Research Society); Submitted on: 05/20/2010 and last confirmed as accurate on 09/14/2010.

Kevin G. Shea, MD 9 (AAOS; American Orthopaedic Society for Sports Medicine; Pediatric Orthopaedic Society of North America); Submitted on: 08/31/2010 and last confirmed as accurate on 10/19/2010.

Jennifer M. Weiss, MD: 9 (Pediatric Orthopaedic Society of North America); Submitted on: 08/09/2010 and last confirmed as accurate on 09/10/2010.

Michael J. Goldberg, MD: 8 (Journal Children's Orthopaedics; Journal of Pediatric Orthopedics); 9 (AAOS); Submitted on: 04/05/2010 and last confirmed as accurate on 10/16/2010.

William Charles Watters III, MD: 3B (Stryker); 4 (Intrinsic Orthopedics); 8 (Official Disability Guidelines; Spine; The Spine Journtal); 9 (American Board of Spine Surgery;

North American Spine Society); Submitted on: 05/26/2010 and last confirmed as accurate on 09/14/2010.

Disclosure Items Answered: (n) = Respondent answered 'No' to all items indicating no conflicts. 1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/Orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society.

APPENDIX XIII
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Ref Type: Online Source

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APPENDIX XIV
INCONCLUSIVE RECOMMENDATIONS PUBLISHED IN THE 2010 GUIDELINE

RECOMMENDATION 2

We are unable to recommend for or against x-rays on the contralateral asymptomatic knee in patients with confirmed OCD of one knee.

Strength of Recommendation: Inconclusive

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

Implications: Practitioners should feel little constraint in following a recommendation labeled as **Inconclusive,** exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

Rationale

We were unable to find quality evidence to support or recommend against obtaining x- rays on the opposite knee for patients with confirmed OCD on one knee.

Supporting Evidence

There is no evidence to address this recommendation.

RECOMMENDATION 4

We are unable to recommend for or against non-operative treatment (casting, bracing, splinting, unloader brace, electrical or ultrasound bone stimulators, or activity restriction alone) for **asymptomatic** skeletally immature patients with OCD.

Strength of Recommendation: Inconclusive

> Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.
>
> Implications: Practitioners should feel little constraint in following a recommendation labeled as **Inconclusive,** exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

Rationale

We were unable to find any evidence to support non-operative treatment for asymptomatic skeletally mature patients with OCD. Therefore, we are unable to recommend for or against treatment in this patient population.

Supporting Evidence

There is no evidence to address this recommendation.

RECOMMENDATION 5

We are unable to recommend for or against a specific non-operative treatment (casting, bracing, splinting, unloader brace, electrical or ultrasound bone stimulators, or activity restriction alone) for **symptomatic** skeletally immature patients with OCD.

Strength of Recommendation: Inconclusive

> Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.
>
> Implications: Practitioners should feel little constraint in following a recommendation labeled as **Inconclusive,** exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

Rationale

No conclusions can be made regarding the non-operative management of symptomatic skeletally immature patients. The AAOS systematic review found no prospective studies that determined the efficacy of non operative treatment in this patient population.

Supporting Evidence

There is no evidence to address this recommendation.

EXCLUDED STUDIES

Table 13 Excluded studies - Recommendation 5

Author	Title	Reason for Exclusion
Wall 2008	The healing potential of stable juvenile osteochondritis dissecans knee lesions	Prognostic data only
Gebarski 2005	Stage-I osteochondritis dissecans versus normal variants of ossification in the knee in children	No quantitative data/Retrospective case series
Cepero 2005	Osteochondritis of the femoral condyles in children and adolescents: our experience over the last 28 years	Less than 10 patients per group
Bramer 2004	Increased external tibial torsion and osteochondritis dissecans of the knee	Less than 10 patients per group
Pill 2003	Role of magnetic resonance imaging and clinical criteria in predicting successful nonoperative treatment of osteochondritis dissecans in children	Retrospective case series

Jurgensen 2002	Arthroscopic versus conservative treatment of osteochondritis dissecans of the knee: value of magnetic resonance imaging in therapy planning and follow-up	Combines the results of skeletally immature patients and skeletally mature patients
Prakash 2002	Natural progression of osteo-chondral defect in the femoral condyle	Combines the results of skeletally immature patients and skeletally mature patients/ Less than 10 patients per group
Sales de Gauzy1999	Natural course of osteochondritis dissecans in children	Retrospective case series
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Combines the results of skeletally immature patients and skeletally mature patients and the results of multiple treatments
Yoshida 1998	Osteochondritis dissecans of the femoral condyle in the growth stage	Retrospective case series
Paletta 1998	The prognostic value of quantitative bone scan in knee osteochondritis dissecans. A preliminary experience	No patient-oriented outcomes
De Smet 1997	Untreated osteochondritis dissecans of the femoral condyles: prediction of patient outcome using radiographic and MR findings	Combines the results of skeletally immature patients and skeletally mature patients/ Less than 10 patients per group
Cahill 1989	The results of conservative management of juvenile osteochondritis dissecans using joint scintigraphy. A prospective study	Prognostic data only

Table 13 Excluded studies - Recommendation 5

Author	Title	Reason for Exclusion
Desai 1987	Osteochondritis dissecans of the patella	Less than 10 patients per group
Hughston 1984	Osteochondritis dissecans of the femoral condyles	Combines the results of skeletally immature patients and skeletally mature patients
Cahill 1983	99m-Technetium phosphate compound joint scintigraphy in the management of juvenile osteochondritis dissecans of the femoral condyles	Prognostic data only
Lindholm 1979	Treatment of juvenile osteochondritis dissecans in the knee	Retrospective case series
Linden 1977	Osteochondritis dissecans of the femoral condyles: a long-term follow-up study	Retrospective case series/Combines the results of skeletally immature and skeletally mature patients
Lindholm 1974	Osteochondritis dissecans of the knee. A clinical study	Combines the results of skeletally immature patients and skeletally mature patients
Aichroth 1971	Osteochondritis dissecans of the knee. A clinical survey	Retrospective case series

PROGNOSTIC EVIDENCE

Two Level IV studies[19, 50] (n = 123), examined factors that might influence the rate of healing of children and adolescent patients with OCD treated non-operatively (See Table 16). One study[19] conducted formal regression analyses and examined the predictive influence of the patients' age, symptoms (isolated or mechanical) and lesion dimensions (length, width and surface area) with the "progression towards healing." The authors of this study defined progression towards healing as radiographic evidence of reossification of the lesion. This study also examined other patient characteristics such as sex and lesion location, but these factors were not statistically significant and were not included in the final analysis. This study failed to examine other important variables that could affect outcomes such as BMI, function etc. This study examined the predictive influence of patient symptoms on healing but included patients with pain in both their "isolated" and "mechanical" symptom categories without quantifying the amount of pain patients were experiencing; therefore, the results for this variable are inconclusive.

A second study[50] reported varying statistical analyses and the results from post hoc tests (χ^2, regression, and discriminate analysis) that examined patients' age, lesion size and location with the success or failure of non-operative treatment for patients with OCD.

Both studies reported lesion size as an influential predictor of healing. Statistically significantly more patients with smaller lesions had the tendency to heal or progress towards healing than patients with larger lesions (See Table 14 and Table 15 and Table 17 - Table 19). The authors of both studies reported no other influential or statistically significant predictors of healing for patients with osteochondritis dissecans of the knee who were treated non-operatively.

Please note the prognostic studies cannot be used as supporting evidence for a recommendation if it did not investigate the results of the effect of the treatment and/or the population of interest for the recommendation. The work group specified that the recommendations throughout this guideline are intended to be mutually exclusive.

SUMMARY OF PROGNOSTIC EVIDENCE

Table 14 Summary of prognostic evidence - Recommendation 5

Study	LOE	Outcome	Duration	Age	Sex	Length and width	Lesion size	Lesion Location	Symptoms
Wall 2009	IV	Progression towards healing	6 months	○	○	●↓	●↓	○	●↓

Progression towards healing: radiographic evidence of reossification of the lesion; Normalized lesion size: surface area of the lesion relative to the surface area of the femoral condyle; Symptoms comparison: asymptomatic or pain only vs. pain with other signs and symptoms; ● Statistically significant predictor; ○ not a statistically significant predictor; ↑ increase in/presence of predictor associated with better performance on outcome; ↓increase in/presence of predictor associated with poorer performance on outcome

Table 15 Summary of prognostic evidence continued– Recommendation 5

Study	LOE	Outcome	Duration (mean)	Age	Lesion size	Lesion Location
Cahill 1989	IV	Success vs. Failure	4.2 years	○	●↓	○

Success defined as scintigraphic and radiographic lesion healing and the ability to reenter sports and exercise programs w/o scintigraphic reactivitation or recurrence of symptoms; age comparison: 12.1yrs vs. 13 yrs; lesion size comparison: 3.1cm2 vs. 4.4 cm2; Lesion location comparison: medial vs. lateral; ● Statistically significant predictor; ○ not a statistically significant predictor; ↑ increase in/presence of predictor associated with better performance on outcome; ↓increase in/presence of predictor associated with poorer performance on outcome

PROGNOSTIC STUDY QUALITY

Table 16 Quality of prognostic studies - Recommendation 5

● = Yes ○ = No n/a = Not applicable	Wall 2008	Cahill 1989
Level of Evidence	IV	IV
N	47	76
Prognostic Factor(s):	Age, sex, symptoms, lesion size, lesion surface area	Age, indications for surgery, lesion size
Quality Questions:		
Prospective	○	●
At Least 10 Patients per Important Variable	●	●
At Least 10 Events	●	●
All Important Variables Screened for Model	○	○
Interactions Tested	●	○
Collinearity Absent	●	○
Primary Analysis (not subgroup or post hoc)	●	○
Statistically Significant Fit	●	○
Article and Abstract Agree	●	●
Results Reported for All Studied Variables	●	○
Blinded Data Analysts	○	n/a

Table 17 Prognostic factors; Primary model - Recommendation 5

Author	N	LOE	Outcome[1]	Factor	Unit of comparison	Odds Ratio (95% CI)	p-value
Wall 2008	47	IV	Healing	Age	2 yr decrease	1.95 (0.62 - 6.09)	p = 0.25
Wall 2008	47	IV	Healing	Symptom category[2]	Isolated or Mechanical[1]	6.89 (1.46 - 32.63)	p = 0.015
Wall 2008	47	IV	Healing	Scaled surface area	5% decrease	5.36 (1.56 - 18.41)	p = <0.01

Table 18 Prognostic factors; Secondary model - Recommendation 5

Author	N	LOE	Outcome[1]	Factor	Unit of comparison	Odds Ratio (95% CI)	p-value
Wall 2008	47	IV	Healing	Age	2 yr decrease	1.90 (0.60 - 6.04)	p = 0.27
Wall 2008	47	IV	Healing	Symptom category[2]	Isolated or Mechanical[1]	6.89 (1.46 - 32.63)	p = 0.015
Wall 2008	47	IV	Healing	Lesion Length	15% decrease	2.0 (0.83 - 4.78)	p = 0.01[3]
Wall 2008	47	IV	Healing	Lesion Width	5% decrease	2.21 (0.96 - 5.09)	

[1] Healing: Progressing towards healing; radiographic evidence of reossification of the lesion after six months of treatment; [2]Symptom Category: Isolated symptoms, asymptomatic or pain only; mechanical, pain and swelling, locking, clicking or giving-way; [3] Statistically significant when the effect of lesion length and lesion width are combined; LOE: level of evidence

Table 19 Prognostic factors continued - Recommendation 5

Author	N	LOE	Outcome	Factor	Correlation Coefficient	p-value[1]
Cahill 1989	76	IV	Success vs. Failure	Age: 12.1 vs.13.0 yrs	Nr	ns
Cahill 1989	76	IV	Success vs. Failure	Lesion size: 3.1cm^2 vs. 4.4 cm^2	Nr	nr*
Cahill 1989	76	IV	Success vs. Failure	Lesion location: medial vs. lateral	Nr	ns
Cahill 1989	76	IV	Failure	Lesion size^2	r = 0.3	nr*

*nr: Authors reported as statistically significant but do not report p-values; ns: authors reported not statistically significant but do not report p-values.

EXCLUDED PROGNOSTIC STUDIES

Table 20 Excluded prognostic studies - Recommendation 5

Author	Title	Reason for Exclusion
Gebarski 2005	Stage-I osteochondritis dissecans versus normal variants of ossification in the knee in children	No quantitative data
Pill 2003	Role of magnetic resonance imaging and clinical criteria in predicting successful nonoperative treatment of osteochondritis dissecans in children	Not best available evidence
Prakash 2002	Natural progression of osteo-chondral defect in the femoral condyle	Combines the results of skeletally immature patients and skeletally mature patients/ Less than 10 patients per group
Sales 1999	Natural course of osteochondritis dissecans in children	No quantitative data
Paletta 1998	The prognostic value of quantitative bone scan in knee osteochondritis dissecans. A preliminary experience	No patient-oriented outcomes
Yoshida 1998	Osteochondritis dissecans of the femoral condyle in the growth stage	Not best available evidence
De Smet 1997	Untreated osteochondritis dissecans of the femoral condyles: prediction of patient outcome using radiographic and MR findings	Not best available evidence

Author	Title	Reason for Exclusion
Bradley 1989	Osteochondritis dissecans and other lesions of the femoral condyles	No quantitative data
Mesgarzadeh 1987	Osteochondritis dissecans: analysis of mechanical stability with radiography, scintigraphy, and MR imaging	No patient-oriented outcomes
Cahill 1983	99m-Technetium phosphate compound joint scintigraphy in the management of juvenile osteochondritis dissecans of the femoral condyles	No quantitative data
Mubarak 1981	Juvenile osteochondritis dissecans of the knee: etiology	Not best available evidence
Linden 1977	Osteochondritis dissecans of the femoral condyles: a long-term follow-up study	Insufficient quantitative data

RECOMMENDATION 6

We are unable to recommend for or against arthroscopic drilling in **symptomatic** skeletally immature patients with a stable lesion(s) who have failed to heal with non-operative treatment for at least three months.

Strength of Recommendation: Inconclusive

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

Implications: Practitioners should feel little constraint in following a recommendation labeled as **Inconclusive,** exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

Rationale

AAOS conducted a systematic review examining arthroscopic drilling for stable symptomatic OCD lesions in skeletally immature patients. We were unable to find any quality evidence to support arthroscopic drilling for symptomatic skeletally mature patients with OCD. Therefore, we are unable to recommend for or against drilling in this patient population.

AAOS conducted a systematic review examining arthroscopic drilling for stable symptomatic OCD lesions in skeletally immature patients and the data were inconclusive.

Supporting Evidence

There is no evidence to address this recommendation.

EXCLUDED STUDIES

Table 21 Excluded studies - Recommendation 6

Author	Title	Reason for Exclusion
Hayan 2009	Juvenile osteochondritis of femoral condyles: treatment with transchondral drilling. Analysis of 40 cases	Retrospective case series
Adachi 2009	Functional and radiographic outcome of stable juvenile osteochondritis dissecans of the knee treated with retroarticular drilling without bone grafting	Retrospective case series
Donaldson 2008	Extraarticular drilling for stable osteochondritis dissecans in the skeletally immature knee	Retrospective case series
Cepero 2005	Osteochondritis of the femoral condyles in children and adolescents: our experience over the last 28 years	Retrospective case series
Jurgensen 2002	Arthroscopic versus conservative treatment of osteochondritis dissecans of the knee: value of magnetic resonance imaging in therapy planning and follow-up	Not relevant - no failed non-op
Kocher 2001	Functional and radiographic outcome of juvenile osteochondritis dissecans of the knee treated with transarticular arthroscopic drilling	Not best available evidence
Anderson 1997	Antegrade drilling for osteochondritis dissecans of the knee	Retrospective case series
Aglietti 1994	Arthroscopic drilling in juvenile osteochondritis dissecans of the medial femoral condyle	Retrospective case series
Bradley 1989	Results of drilling osteochondritis dissecans before skeletal maturity	Retrospective case series
Guhl 1982	Arthroscopic treatment of osteochondritis dissecans	Not relevant - no failed non-op
Lindholm 1979	Treatment of juvenile osteochondritis dissecans in the knee	Less than 10 patients per group - combines adults and children
Aichroth 1971	Osteochondritis dissecans of the knee. A clinical survey	Less than 10 patients per Tx group

PROGNOSTIC EVIDENCE

One Level IV [51] and one Level V [52] study (n = 62) reported skeletally immature patients with stable lesions treated with drilling (transarticular or retrograde); all patients had unsuccessful conservative treatment. One study[52] reported the results of post-hoc analyses to determine any possible influential factors on Hughston clinical scores. The Hughston clinical score is a composite outcome which provides unreliable results. The results are unreliable due to the unequal contribution or influential effect each component provides to the significance of the overall results.[53-55] Studies suggest examining the results of the individual outcome measures along with the results of the composite outcome measures to ensure a comprehensive examination of the effects of a given treatment but the authors do not report the results of each outcome component individually. The prognostic results are provided for informational purposes only. No reliable conclusions can be made due to the inconsistencies within the reported results. Patients with closed growth plates (5 %) had statistically significantly lower Hughston clinical scores than patients with open growth plates (95%) ($p < 0.001$); no other statistically significant predictors were reported (See Table 23). A second study[51] also reported the results based on post hoc analyses and examined age, sex, lesion size, involved side, bilateral lesions, the presence of sclerosis and the presence of fragmentation of the lesion with Lysholm scores and found that younger patients had statistically significant lower Lysholm scores than older patients; no specific ages were reported (See Table 23).

Please note the prognostic studies cannot be used as supporting evidence for a recommendation if it did not investigate the results of the effect of the treatment and/or the population of interest for the recommendation. The work group specified that the recommendations throughout this guideline are intended to be mutually exclusive.

PROGNOSTIC STUDY QUALITY

Table 22 Quality for prognostic studies - Recommendation 6

Author	Hayan 2009	Kocher 2001
Level of Evidence	V	IV
N	39	23
Prognostic Factor(s):	growth plate, lesion volume, size, and location	age, sex, involved side, bilaterality, presence of sclerosis, or fragmentation, lesion size
Quality Questions:		
Prospective	○	●
At Least 10 Patients per Important Variable	○	○
At Least 10 Events	n/a	n/a
All Important Variables Screened for Model	●	●
Interactions Tested	○	○
Collinearity Absent	○	○
Primary Analysis (not subgroup or post hoc)	●	●
Statistically Significant Fit	○	○
Article and Abstract Agree	●	●
Results Reported for All Studied Variables	●	●
Blinded Data Analysts	n/a	n/a

● = Yes ○ = No n/a = Not applicable

PROGNOSTIC STUDY RESULTS

Table 23 Prognostic factors and Hughston and Lysholm scores - Recommendation 6

Author	LOE	n	Power	Outcome	Age	Sex	Lesion size	Lesion location	Lesion stage	Growth plate closure	Involved side	Bilaterality	Presence or absence of sclerosis	Presence or absence of fragmentation
Hayan 2009	V	40	High	Hughston clinical score	-	-	○	○	○	●↓	-	-	-	-
Kocher 2001	IV	23	Moderate	Lysholm Score	●↓	○	○	-	-	-	○	○	○	○

●: Statistically significant predictor; ○: not a statistically significant predictor; - predictor not addressed by the study; ↑: increase in/presence of predictor associated with better performance on outcome; ↓: increase in/presence of predictor associated with poorer performance on outcome

Table 24 Excluded prognostic studies - Recommendation 6

Author	Title	Reason for Exclusion
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Combines the results of skeletally immature patients and skeletally mature patients and the results of multiple treatments
Mitsuoka 1999	Osteochondritis dissecans of the lateral femoral condyle of the knee joint	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients per group

RECOMMENDATION 8

We are unable to recommend for or against a specific cartilage repair technique in **symptomatic** skeletally immature patients with unsalvageable fragment.

Strength of Recommendation: Inconclusive

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

Implications: Practitioners should feel little constraint in following a recommendation labeled as **Inconclusive,** exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

Rationale

The AAOS conducted a systematic review of the literature and found one quality study to address this recommendation. Because there was only one Level II study and many applicable outcomes and techniques were not addressed, the results of this single study were evaluated as inconclusive.

Supporting Evidence

AAOS conducted a search for the following cartilage repair techniques: abrasion arthroplasty, autologous chondrocyte implantation (ACI), osteochondral allograft and autograft, chondroplasty, microfracture, moscicplasty and osteochondral autograft transplantation (OAT).

The term chondroplasty was included to keep the search inclusive and possibly include those articles that had a mixed patient population including those receiving chondroplasty (which is not a cartilage repair procedure) as well as those noted in the study as discretely receiving true cartilage repair procedures.

We included one Level II study [42] (n = 47) that reported the results of children and adolescents between the ages of 12 and 15 years who were treated with either microfracture or osteochondral autologous transplantation (OAT) (See Table 32). This study reported the International Cartilage Repair Society Score (ICRS), return to activities, symptoms and the complications of patients up to 50 months following treatment. Patients treated with autologous transplantation had statistically significant greater ICRS scores at 24 - 48 months following treatment and a greater percentage of patients returned to their pre-injury level of activities of daily living compared to patients treated with microfracture (See Table 30 and Table 32). Additionally, patients treated with OAT had statistically significant fewer failures which consequently resulted in fewer revisions and/or secondary surgical procedures. There was no statistically significant difference in the number of patients with pain following treatment. The authors reported patients treated with OAT had statistically significantly more crepitation

than patients treated with microfracture but AAOS calculations cannot confirm these results.

SUMMARY OF RESULTS

Table 31 Microfracture vs. Autologous Transplantation - Recommendation 8

Outcome	n	Duration (months)	Favored Group	Power
ICRS -Function	47	24	OAT	High
	47	36	OAT	High
	47	48	OAT	High
Activities of Daily Living	47	50	OAT	High
Pain	47	nr	Neither	Low
Swelling	47	14-34 days	OAT	High
Crepitation	47	nr	Neither	Low
Failures	47	50	OAT	High
Revision	47	50	OAT	High
Secondary Surgical Procedure	47	50	OAT	High

OAT: Osteochondral Autologous Transplantation; ICRS: International Cartilage Repair Society Score; ○: no statistically significant difference; nr: not reported

STUDY QUALITY

Table 32 Quality of randomized controlled trials - Recommendation 8

Author	Outcome	Duration (months)	n	Level of Evidence	Stochastic Randomization	Allocation Concealment	Patients Blinded	Those Rating Outcome Blinded	Follow Up - 80% or more	All groups have similar outcome performance at entry
Gudas 2009	ICRS	24	47	Level II	●	●	●	○	●	●
Gudas 2009	ICRS	36	47	Level II	●	●	●	○	●	●
Gudas 2009	ICRS	48	47	Level II	●	●	●	○	●	●
Gudas 2009	Return to Activities	50	47	Level II	●	●	●	○	●	●
Gudas 2009	Symptoms	nr	47	Level II	●	●	●	○	●	●
Gudas 2009	Failures	50	47	Level II	●	●	●	○	●	●

● = Yes ○ = No; ICRS: International Cartilage Repair Society Score; nr: not reported

STUDY RESULTS

Table 33 International Cartilage Repair Society Score - Recommendation 8

Study	LOE	n	Duration (months)	OAT (mean)	MF (mean)	p - value	Favored Treatment	Power
Gudas 2009	II	47	24	84	75	p <0.001	OAT	High
			36	84	64	p <0.001	OAT	
			48	83	63	p <0.001	OAT	

Mean values reported, no variance reported; LOE: level of evidence; OAT: Osteochondral Autologous Transplantation; MF: microfracture; ICRS: International Cartilage Repair Society Score; range 0-100 pts;

Table 34 Return to activities - Recommendation 8

Study	LOE	n	Outcome	Duration (months)	OAT	MF	p-value	Favored Treatment	Power
Gudas 2009	II	47	Same level	50	68% (17/25)	14% (3/22)	p <0.001	OAT	High

LOE: level of evidence; OAT: Osteochondral Autologous Transplantation; MF: microfracture

Table 35 Complications - Recommendation 8

Study	LOE	n	Outcome	Duration (months)	OAT	MF	p–value[1]	Favored Treatment	Power
Gudas 2009	II	47	Pain	nr	36% (9/25)	59% (13/22)	p = 0.110	○	High
			Swelling	14-34 days	8% (2/25)	45% (10/22)	p = 0.002	OAT	
			Crepitation	nr	40% (10/25)	18% (4/22)	p = 0.095[2]	○	
			Failures	50	20% (5/25)	73% (16/22)	p <0.001	OAT	
			Revision	50	0%	64% (14/22)	p <0.001	OAT	
			Secondary Surgical Procedure	50	0%	9.1% (2/22)	p = 0.036	OAT	

[1] p-value based on the test of arcsine difference; ○ No statistically significant difference; LOE: level of evidence; OAT: Osteochondral Autologous Transplantation; MF: microfracture;

EXCLUDED STUDIES

Table 36 Excluded studies - Recommendation 8

Author	Title	Reason for Exclusion
Magnussen 2009	Does operative fixation of an osteochondritis dissecans loose body result in healing and long-term maintenance of knee function?	Combines the results of skeletally immature patients and skeletally mature patients
Miniaci 2007	Fixation of unstable osteochondritis dissecans lesions of the knee using arthroscopic autogenous osteochondral grafting (mosaicplasty)	Less than 80% of children - combines adults and children
Miura 2007	Results of arthroscopic fixation of osteochondritis dissecans lesion of the knee with cylindrical autogenous osteochondral plugs	Combines the results of adults and children
Micheli 2006	Articular cartilage defects of the distal femur in children and adolescents: treatment with autologous chondrocyte implantation	Less than 80% w/ OCD -Combines results of patients with other cartilage defects
Jurgensen 2002	Arthroscopic versus conservative treatment of osteochondritis dissecans of the knee: value of magnetic resonance imaging in therapy planning and follow-up	Less than 10 patients per group
Navarro 2002	The arthroscopic treatment of osteochondritis dissecans of the knee with autologous bone sticks	Less than 10 patients per group/Retrospective case series
Zmerly 2000	The treatment of cartilage injuries in footballers	Combines the results of skeletally immature patients and skeletally mature patients
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Combines the results of skeletally immature patients and skeletally mature patients and the results of multiple treatments
Mitsuoka 1999	Osteochondritis dissecans of the lateral femoral condyle of the knee joint	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients per group
Johnson 1990	Osteochondritis dissecans of the knee: arthroscopic compression screw fixation	Less than 80% of children- combines adults and children/Confounding results - combines the results of multiple treatments

Table 36 Excluded studies - Recommendation 8

Author	Title	Reason for Exclusion
Jakob 1989	A compression pinning system for osteochondritis dissecans of the knee	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients
Hughston 1984	Osteochondritis dissecans of the femoral condyles	Combines the results of skeletally immature patients and skeletally mature patients
Gillespie 1979	Bone peg fixation in the treatment of osteochondritis dissecans of the knee joint	Retrospective case series/Combines the results of skeletally immature patients and skeletally mature patients
Lindholm 1979	Treatment of juvenile osteochondritis dissecans in the knee	Combines the results of adults and children

PROGNOSTIC EVIDENCE

One Level V study[42] (n = 47) reported the prognostic factors of juvenile and adolescent patients with unstable (ICRS Grade III and IV) OCD lesions treated with either debridement and microfracture (MF) or osteochondral autologous transplantation (OAT). Although the results are discussed, no conclusions can be made due to inconsistencies in the data the authors provided and also the results reported without inconsistencies are conflicting. The inconsistencies reported are an overlap in the subgroups that were analyzed ($< 3cm^2$ vs. $>2cm^2$) and subgroups were removed from the results examining prognostic factors but were included in the analyses examining the results of patients treated with MF or OAT. In addition, it unclear as to whether or not some of the results reported only included patients from one treatment group or whether the results analyze all the patients included regardless of their treatment group. Further, conflicting results were reported in that lesion size statistically significantly influenced the results of one treatment group but not the other.

The authors reported that lesion size significantly influenced the ICRS score of patients treated with MF but lesion size was not statistically influential in patients treated with OAT (Table 38). Age did not significantly influence ICRS scores in either treatment group (See Table 40). The duration of symptoms of patients with ICRS grade of excellent was statistically significantly less than patients with an ICRS grade of fair or poor (20 months vs. 25 months) (See Table 41).

Please note the prognostic studies cannot be used as supporting evidence for a recommendation if it did not investigate the results of the effect of the treatment and/or the population of interest for the recommendation. The work group specified that the recommendations throughout this guideline are intended to be mutually exclusive.

PROGNOSTIC STUDY QUALITY
Table 37 Prognostic study quality

Author	Gudas 2009
Level of Evidence	V
N	47
Prognostic Factor(s):	age, duration of symptoms, lesion size
Quality Questions:	
Prospective	●
At Least 10 Patients per Important Variable	○
At Least 10 Events	n/a
All Important Variables Screened for Model	○
Interactions Tested	○
Collinearity Absent	○
Primary Analysis (not subgroup or post hoc)	○
Statistically Significant Fit	○
Article and Abstract Agree	●
Results Reported for All Studied Variables	○
Blinded Data Analysts	○

● = Yes ○ = No n/a = Not applicable

PROGNOSTIC STUDY RESULTS

Table 38 Lesion size with International Cartilage Repair Society Score

Author	LOE	n	Treatment Group	Duration	Lesion Size	ICRS Score (mean)	p - value	Group Favored
Gudas 2009	V	22	MF	4.2 years	< 3 cm	Nr	p <.05	< 3 cm
					> 2cm	Nr		
		25	OAT		< 3 cm	Nr	p >.05	ns
					> 2cm	Nr		

OAT: Osteochondral Autologous Transplantation; MF: microfracture; nr: not reported; ns: not statistically significant

Table 39 Defect size with International Cartilage Repair Society Score

Author	LOE	n	Treatment Group	Duration	Factor	Results	p - value
Gudas 2009	V	22	MF	4.2 years	Defect Size	$r = 0.516$	p = 0.009
		25	OAT			$r = 0.053$	p = 0.681

OAT: Osteochondral Autologous Transplantation; MF: microfracture; *r*: Pearson correlation coefficient

Table 40 Age with International Cartilage Repair Society Score

Author	LOE	n	Treatment group	Duration	Age Group	ICRS score (mean)	p - value
Gudas 2009	V	OAT (25) MF (22)	OAT or MF	4.2 years	< 14 years	84.4	p >.05
					> 14 years	83.8	

OAT: Osteochondral Autologous Transplantation; MF: microfracture

Table 41 International Cartilage Repair Society grade with duration of symptoms

Author	LOE	n	Treatment Group	Duration	ICRS Grade	Duration of symptoms (median)	p-value	Group Favored
Gudas 2009	V	OAT (25) MF (22)	MF or OAT	4.2 years	Excellent	20 months	p<.05	ICRS Grade: Excellent
Gudas 2009	V	OAT (25) MF (22)	MF or OAT	4.2 years	Fair or Poor	25 months		

OAT: Osteochondral Autologous Transplantation; MF: microfracture

EXCLUDED PROGNOSTIC STUDIES

Table 42 Excluded prognostic studies

Author	Title	Reason for Exclusion
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Combines the results of skeletally immature patients and skeletally mature patients and the results of multiple treatments
Mitsuoka 1999	Osteochondritis dissecans of the lateral femoral condyle of the knee joint	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients per group

RECOMMENDATION 9

We are unable to recommend for or against repeat MRI for **asymptomatic** skeletally mature patients.

Strength of Recommendation: Inconclusive

> Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.
>
> Implications: Practitioners should feel little constraint in following a recommendation labeled as **Inconclusive,** exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

Rationale

We were unable to find quality evidence to support repeat MRI for asymptomatic skeletally mature patients with OCD. Therefore, we are unable to recommend for or against repeat MRI in this patient population.

Supporting Evidence

There is no evidence to address this recommendation.

RECOMMENDATION 10

We are unable to recommend for or against treating asymptomatic skeletally mature patients with OCD progression (as identified by X-ray or MRI) like symptomatic patients.

Strength of Recommendation: Inconclusive

> Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.
>
> Implications: Practitioners should feel little constraint in following a recommendation labeled as **Inconclusive,** exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

Rationale

We were unable to find any evidence to support treating asymptomatic skeletally mature patients with progression of OCD on x-ray and/or MRI as symptomatic skeletally mature patients. Therefore, we are unable to recommend for or against a treatment in this patient population.

Supporting Evidence

There is no evidence to address this recommendation.

RECOMMENDATION 12

We are unable to recommend for or against a specific cartilage repair technique in **symptomatic** skeletally mature patients with an unsalvageable OCD lesions.

Strength of Recommendation: Inconclusive

> Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.
>
> Implications: Practitioners should feel little constraint in following a recommendation labeled as **Inconclusive,** exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

Rationale

There are many different cartilage repair techniques including autologous chondrocyte implantation, osteochondral transplantation using allograft or autograft, and marrow stimulation techniques such as abrasion arthroplasty and microfracture. There were four Level IV studies that addressed cartilage repair techniques for an unsalvageable OCD lesion. Since each of these Level IV articles utilized different techniques, different outcome measures and differing lengths of follow-up, the work group deemed that the evidence for any specific technique was inconclusive.

Supporting Evidence

AAOS conducted a systematic review for the following cartilage repair techniques: abrasion arthroplasty, autologous chondrocyte implantation (ACI), osteochondral allograft and autograft, chondroplasty, microfracture, moscicplasty and osteochondral autograft transplantation (OAT).

The term chondroplasty was included to keep the search inclusive and possibly include those articles that had a mixed patient population including those receiving chondroplasty (which is not a cartilage repair procedure) as well as those noted in the study as discretely receiving true cartilage repair procedures.

We included four Level IV studies[43-46] (n = 118) to address this recommendation (See Table 57 and Table 63). One study[43] reported the results of patients treated with allografts. One study[45] reported the results of patients treated with autologous chondrocyte implantation (ACI) and autografts. The procedure reported by this study has not been approved for use in the United States as of April 2010. Two studies[44, 46]reported the results of patients treated with autologous chondrocyte implantation (ACI).

Patients treated with allografts had statistically significant improvements at 48 months in the Tegner activity, Lysholm, IKDC, KOOS – pain and sport scores (See Table 59 -Table 60 and Table 64Table 69). No statistically significant improvements were reported for KOOS-symptoms, KOOS – activities of daily living, quality of life scores and for both

components of the SF-12 (Mental and Physical) Six percent of patients treated with allografts required secondary surgical procedures.

Two Level IV studies[44,46] (n = 81), reported Lysholm scores, Cincinnati Knee scores, and Modified Cincinnati Knee scores of patients treated with autologous chondrocyte implantation (ACI). One study reported that at 24 months, patients had statistically significant improvements from baseline for all three outcome measures but the improvements at 66 months were not statistically significant (See Table 61 - Table 62 and Table 70 - able 74). The second study did not report the results of any statistical tests for any of the outcomes measures for patients treated with ACI.

One Level IV study[45] reported statistically significant improvements in International Knee Documentation Committee scores at 36 months and reported no statistically significant improvements in Lysholm scores at 36 months (See Table 75 and Table 76).

Table 57 Treatments from included studies - Recommendation 12

Author	Treatment Type	Number of studies
Pascual-Garrido 2009	Allograft	1
Steinhagen 2009,	Autologous Chondrocyte Implantation and Autograft	1
Ossendorf 2007, Peterson 2003	Autologous Chondrocyte Implantation	2

SUMMARY OF RESULTS

Table 58 Tegner, Lysholm and IKDC scores - Allograft

Study	n	LOE	Outcome	Duration (months)	Significant improvement from baseline	Power
Pascual-Garrido 2009	16	IV	Tegner activity score	48	●	Low
Pascual-Garrido 2009	16	IV	Lysholm score	48	●	Low
Pascual-Garrido 2009	16	IV	IKDC score	48	●	Low

LOE: level of evidence; IKDC: International Knee Documentation Committee Score; ○no statistically significant difference; ● statistically significant difference

Table 59 Knee Injury and Osteoarthritis Outcome Score - Allograft

Study	n	LOE	Outcome	Duration (months)	Significant improvement from baseline	Power
Pascual-Garrido 2009	16	IV	Pain	48	●	High
Pascual-Garrido 2009	16	IV	Symptoms	48	○	Low
Pascual-Garrido 2009	16	IV	ADL	48	○	Low
Pascual-Garrido 2009	16	IV	Sport	48	●	High
Pascual-Garrido 2009	16	IV	QOL	48	○	Low

LOE: level of evidence; ○no statistically significant difference; ● statistically significant difference

Table 60 SF-12 Mental and Physical scores - Allograft

Study	n	LOE	Outcome	Duration (months)	Significant improvement from baseline	Power
Pascual-Garrido 2009	16	IV	SF-12-Mental	48	○	Low
Pascual-Garrido 2009	16	IV	SF-12-Physical	48	○	Low

LOE: level of evidence; ○no statistically significant difference; ● statistically significant difference

Table 61 Autologous chondrocyte implantation, Lysholm - Recommendation 12

Study	n	LOE	Outcome	Duration (months)	Significant improvement from baseline	Power
Peterson 2003	58	IV	Modified Lysholm score[1]	24	●	High
Ossendorf 2007	23	IV	Lysholm[2]	avg 36 (range 24-65)	nr	Moderate
Peterson 2003	58	IV	Modified Lysholm score	avg 66 (range 24-120)	○	High

[1] Range 0-90 points; low score, patients have more symptoms and instability performing activities of daily living; [2] Range 0-100 points; low score, patients have more symptoms and instability performing activities of daily living; ○: No statistically significant difference; ●: Statistically significant difference; LOE: level of evidence; nr: not reported

Table 62 Autologous chondrocyte implantation, Cincinnati Knee Score - Recommendation 12

Study	n	LOE	Outcome	Duration (months)	Significant improvement from baseline	Power
Ossendorf 2007	23	IV	Cincinnati Knee Score	36 (24-65)	nr	Moderate
Peterson 2003	58	IV	Modified Cincinnati knee score	24	●	High
Ossendorf 2007	23	IV	Modified Cincinnati knee score	36	nr	Moderate
Peterson 2003	58	IV	Modified Cincinnati knee score	66	○	High

○ No statistically significant difference; ● statistically significant difference; LOE: level of evidence; nr: not reported

STUDY QUALITY
Table 63 Quality of case series studies - Recommendation 12

● = Yes ○ = No × = Not Reported
n/a = not applicable

Author	Outcome	n	Treatment	Level of Evidence	Consecutive enrollment of patients	Follow Up - 80% or more	All patients evaluated using same outcome measures	All patients receive same treatment	All pateints have approximately equal follow-up times
Pacual-Garrido 2009	Tegner	16	Allograft	Level IV	●	●	●	●	●
Pacual-Garrido 2009	Lysholm	16	Allograft	Level IV	●	●	●	●	●
Pacual-Garrido 2009	IKDC	16	Allograft	IV	●	●	●	●	●
Pacual-Garrido 2009	KOOS - Pain	16	Allograft	Level IV	●	●	●	●	●
Pacual-Garrido 2009	KOOS - Symptoms	16	Allograft	Level IV	●	●	●	●	●
Pacual-Garrido 2009	KOOS - ADL	16	Allograft	Level IV	●	●	●	●	●
Pacual-Garrido 2009	KOOS - Sport	16	Allograft	Level IV	●	●	●	●	●
Pacual-Garrido 2009	KOOS - QOL	16	Allograft	Level IV	●	●	●	●	●
Pacual-Garrido 2009	SF-12 Mental	16	Allograft	Level IV	●	●	●	●	●
Pacual-Garrido 2009	SF-12 Physical	16	Allograft	Level IV	●	●	●	●	●
Steinhagen 2009	Lysholm Score	16	Bone graft with ACI	Level IV	●	●	●	●	●

Table 63 Quality of case series studies - Recommendation 12

● = Yes ○ = No × = Not Reported
n/a = not applicable

Author	Outcome	n	Treatment	Level of Evidence	Consecutive enrollment of patients	Follow Up - 80% or more	All patients evaluated using same outcome measures	All patients receive same treatment	All pateints have approximately equal follow-up times
Steinhagen 2009	IKDC	21	Bone graft with ACI	Level IV	●	●	●	●	●
Steinhagen 2009	Global assessment	21	Bone graft with ACI	Level IV	●	●	●	●	●
Ossendorf 2007	Lysholm Score	23	ACI	Level IV	●	●	●	●	●
Ossendorf 2007	ICRS Score	23	ACI	Level IV	●	●	●	●	●
Ossendorf 2007	Cincinnati Score	23	ACI	Level IV	●	●	●	●	●
Ossendorf 2007	Modified Cincinnati Score	23	ACI	Level IV	●	●	●	●	●
Peterson 2003	Lysholm Score	58	ACI	Level IV	●	●	●	●	●
Peterson 2003	Cincinnati Rating	58	ACI	Level IV	●	●	●	●	●
Peterson 2003	Tegner – Wallgren Score	58	ACI	Level IV	●	●	●	●	●
Peterson 2003	Brittberg – Peterson Score (VAS)	58	ACI	Level IV	●	●	●	●	●
Peterson 2003	Patient assessment of treatment results	58	ACI	Level IV	●	●	●	●	●

IKDC: International Knee Documentation Committee Score; International Cartilage Repair Society Score; KSS: Knee Society Score; VAS: Visual Analog Scale; KOOS: Knee Injury and Osteoarthritis Outcome Score

STUDY RESULTS

Table 64 Tegner activity score - Allograft

Author	n	LOE	Duration (months)	Results*	p- value
Pascual-Garrido 2009	16	IV	pre-op	0	p = <0.001
Pascual-Garrido 2009	16	IV	48	6	

*Values presented as mean values

Table 65 Lysholm score - Allograft

Author	n	LOE	Duration (months)	Results*	p- value
Pascual-Garrido 2009	16	IV	pre-op	25	p = 0.015
Pascual-Garrido 2009	16	IV	48	37	

*Values presented as mean values

Table 66 International Knee Documentation Committee Score - Allograft

Author	n	LOE	Duration (months)	Results*	p- value
Pascual-Garrido 2009	16	IV	pre-op	31	p = 0.004
Pascual-Garrido 2009	16	IV	48	45	p = 0.004

*Values presented as mean values

Table 67 Knee Injury and Osteoarthritis Outcome score - Allograft

Author	n	LOE	Duration (months)	Outcome	Results*	p- value
Pascual-Garrido 2009	16	IV	pre-op	Pain	52	p = 0.002
Pascual-Garrido 2009	16	IV	48		74	
Pascual-Garrido 2009	16	IV	pre-op	Symptoms	59	p = 0.270
Pascual-Garrido 2009	16	IV	48		67	
Pascual-Garrido 2009	16	IV	pre-op	ADL	57	p = 0.200
Pascual-Garrido 2009	16	IV	48		67	
Pascual-Garrido 2009	16	IV	pre-op	Sport	32	p = 0.037
Pascual-Garrido 2009	16	IV	48		46	
Pascual-Garrido 2009	16	IV	pre-op	QOL	29	p = 0.062
Pascual-Garrido 2009	16	IV	48	QOL	39	p = 0.062

*Values presented as mean values

Table 68 Short-form 12 Mental and Physical scores - Allograft

Author	n	LOE	Duration (months)	Outcome	Results*	p-value
Pascual-Garrido 2009	16	IV	pre-op	Mental	49	p = 0.407
Pascual-Garrido 2009	16	IV	48		57	
Pascual-Garrido 2009	16	IV	pre-op	Physical	41	p = 0.087
Pascual-Garrido 2009	16	IV	48		43	

*Values presented as mean values

Table 69 Secondary surgical procedures - Allograft

Author	n	LOE	Duration (months)	Outcome	Results	p- value
Pascual-Garrido 2009	16	IV	48	Secondary Surgical Procedures	6.3% (1/16)	nr

Table 70 Lysholm score - autologous chondrocyte implantation

Study	n	LOE	Outcome	Duration	Mean (SD)	p - value	Power
Ossendorf 2007	23	IV	Lysholm score[1]	pre-op	34 (SD 3.1)[3]	nr	Moderate
Ossendorf 2007	23	IV	Lysholm score[1]	36	74 (SD 3.4)[3]	nr	Moderate
Peterson 2003	58	IV	Modified Lysholm score[2]	pre-op	44.3 (nr)	ns	High
Peterson 2003	58	IV	Modified Lysholm score[2]	24	89.3 (nr)	p<0.001	High
Peterson 2003	58	IV	Modified Lysholm score[2]	66	92.4 (nr)	ns	High

[1] Range 0-100 points; low score, patients have more symptoms and instability performing activities of daily living; [2] Range 0-90 points; low score, patients have more symptoms and instability performing activities of daily living; [3] Standard deviation calculated from the range; LOE: level of evidence; nr: not reported; ns: not statistically significant

Table 71 Cincinnati Knee Score - autologous chondrocyte implantation

Study	n	LOE	Outcome	Duration (months)	Mean (SD)	p-value	Power
Ossendorf 2007	23	IV	Cincinnati Knee Score[1]	pre-op	26 (SD 2.8)	nr	Moderate
Ossendorf 2008	23	IV	Cincinnati Knee Score[1]	36	77 (SD 3.9)	nr	Moderate
Ossendorf 2007	23	IV	Modified Cincinnati knee score[2]	pre-op	3.27 (SD 1.2)	nr	Moderate
Peterson 2003	58	IV	Modified Cincinnati knee score[2]	pre-op	2 (nr)	nr	High
Peterson 2003	58	IV	Modified Cincinnati knee score[2]	24	8.9 (nr)	p<0.001	High
Ossendorf 2007	23	IV	Modified Cincinnati knee score[2]	36	6.64 (SD 1.4)	nr	Moderate
Peterson 2003	58	IV	Modified Cincinnati knee score[2]	66	9.8 (nr)	ns	High

[1] Range 0 – 100; lower scores indicate worse treatment results; [2] Range 0 – 10; lower scores indicate worse treatment results; LOE: level of evidence; SD: Standard deviation (calculated from range); nr: not reported; ns: not statistically significant.

Table 72 Tegner-Wallgren Score - autologous chondrocyte implantation

Study	n	LOE	Duration	Mean (SD)	p - value	Power
Peterson 2003	58	IV	pre-op	6.3 (nr)	ns	High
Peterson 2003	58	IV	24	8.3 (nr)	p< 0.001	High
Peterson 2003	58	IV	66	10.2 (nr)	ns	High

LOE: level of evidence; SD; standard deviation; nr: not reported; ns: not statistically significant

Table 73 Brittberg-Peterson functional score (VAS) - autologous chondrocyte implantation

Study	n	LOE	Duration (months)	Mean (SD)	p-value	Power
Peterson 2003	58	IV	pre-op	80.2 (nr)	nr	High
Peterson 2003	58	IV	24	31.2 (nr)	p<0.001	High
Peterson 2003	58	IV	66	26.7 (nr)	ns	High

Brittberg-Peterson functional score (VAS): range 0 – 100; lower scores indicates lower levels of function; VAS: Visual Analog Scale; LOE: level of evidence; SD; standard deviation; nr: not reported; ns: not statistically significant

Table 74 Patient's assessment of results - autologous chondrocyte implantation

Study	n	LOE	Outcome	Duration (months)	Results (%)	p-value
Peterson 2003	58	IV	Improved	24	54 (93%)	nr
Peterson 2003	58	IV	Same or Worse		4 (7%)	nr

LOE: level of evidence; nr: not reported

Table 75 Lysholm score - autologous chondrocyte implantation with autograft

Study	n	LOE	Duration (months)	Median	p-value
Steinhagen 2009	21	IV	pre-op	nr	nr
Steinhagen 2009	21	IV	36	90.14	p = 0.11

Lysholm score: range 0-100 points; low score, patients have higher levels of symptoms and instability performing activities of daily living; LOE: level of evidence; nr: not reported

Table 76 International Knee Documentation Committee Score - autologous chondrocyte implantation with autograft

Study	n	LOE	Duration (months)	Mean (SD)	p-value	Power
Steinhagen 2009	21	IV	pre-op	37.9 (SD 13.56)	nr	Moderate
			36	70.29 (SD 14.04)	p<0.001	Moderate

[1] Range 0-100; higher scores represent higher levels of function and lower levels of symptoms; LOE: level of evidence; SD: standard deviation; nr: not reported

EXCLUDED STUDIES

Author	Title	Reason for Exclusion
Fonseca 2009	Fixation with autogenous osteochondral grafts for the treatment of osteochondritis dissecans (stages III and IV)	Retrospective case series
Braun 2008	The 5.5-year results of MegaOATS--autologous transfer of the posterior femoral condyle: a case-series study	<80% OCD
Emmerson 2007	Fresh osteochondral allografting in the treatment of osteochondritis dissecans of the femoral condyle	Not best available evidence
Miniaci 2007	Fixation of unstable osteochondritis dissecans lesions of the knee using arthroscopic autogenous osteochondral grafting (mosaicplasty)	Combines the results of skeletally immature patients and skeletally mature patients
Miura 2007	Results of arthroscopic fixation of osteochondritis dissecans lesion of the knee with cylindrical autogenous osteochondral plugs	Combines the results of skeletally immature patients and skeletally mature patients
Gudas 2006	Osteochondral autologous transplantation versus microfracture for the treatment of articular cartilage defects in the knee joint in athletes	not specific to OCD
Krishnan 2006	Collagen-covered autologous chondrocyte implantation for osteochondritis dissecans of the knee: two- to seven-year results	Combines the results of skeletally immature patients and skeletally mature patients
Gudas 2005	A prospective randomized clinical study of mosaic osteochondral autologous transplantation versus microfracture for the treatment of osteochondral defects in the knee joint in young athletes	Less than 80% OCD
Sharpe 2005	The treatment of osteochondral lesions using a combination of autologous chondrocyte implantation and autograft: three-year follow-up	Retrospective case series
Bramer 2004	Increased external tibial torsion and osteochondritis dissecans of the knee	No baseline data
Laprell 2001	Autologous osteochondral transplantation using the diamond bone-cutting system (DBCS): 6-12 years' follow-up of 35 patients with osteochondral defects at the knee joint	Less than 80% with OCD/Retrospective case series
Zmerly 2000	The treatment of cartilage injuries in footballers	Combines the results of skeletally immature patients and skeletally mature patients
Outerbridge 2000	Osteochondral defects in the knee. A treatment using lateral patella autografts	Retrospective case series

Author	Title	Reason for Exclusion
Peterson 2000	Two- to 9-year outcome after autologous chondrocyte transplantation of the knee	Patients reported in a more recent publication
Madsen 2000	Long-term results of periosteal transplantation in osteochondritis dissecans of the knee	Retrospective case series
Hefti 1999	Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society	Combines the results of skeletally immature patients and skeletally mature patients and the results of multiple treatments
Mitsuoka 1999	Osteochondritis dissecans of the lateral femoral condyle of the knee joint	Combines the results of skeletally immature patients and skeletally mature patients/Less than 10 patients per group
Fabbriciani 1998	Osteochondral autografts in the treatment of osteochondritis dissecans of the knee	Retrospective case series
Nicholson 1998	Role of carbon fibre implants in osteochondral defects of the knee	Not relevant - not OCD
Marcacci 1998	Autologous grafts for knee osteochondral defect reconstruction in adults	Retrospective case series
Angermann 1998	Osteochondritis dissecans of the femoral condyle treated with periosteal transplantation. Poor outcome in 14 patients followed for 6-9 years	Retrospective case series
De 1997	Untreated osteochondritis dissecans of the femoral condyles: prediction of patient outcome using radiographic and MR findings	Combines the results of skeletally immature patients and skeletally mature patients/ Less than 10 pts
Garrett 1994	Fresh osteochondral allografts for treatment of articular defects in osteochondritis dissecans of the lateral femoral condyle in adults	Retrospective case series
Ewing 1988	Arthroscopic surgical management of osteochondritis dissecans of the knee	Retrospective case series
Schwarz 1988	The results of operative treatment of osteochondritis dissecans of the patella	No baseline data
Desai 1987	Osteochondritis dissecans of the patella	Less than 10 patients per group
Denoncourt 1986	Arthroscopy update #1. Treatment of osteochondrosis dissecans of the knee by arthroscopic curettage, follow-up study	Surgical technique not relevant
Hughston 1984	Osteochondritis dissecans of the femoral condyles	Combines the results of skeletally immature patients and skeletally mature patients
Guhl 1982	Arthroscopic treatment of osteochondritis dissecans	Less than 10 patients per group

Author	Title	Reason for Exclusion
Lindholm 1979	Treatment of juvenile osteochondritis dissecans in the knee	Combines the results of skeletally immature patients and skeletally mature patients
Lindholm 1974	Osteochondritis dissecans of the knee. A clinical study	Combines the results of skeletally immature patients and skeletally mature patients
Langer 1971	Osteochondritis dissecans and anomalous centres of ossification: a review of 80 lesions in 61 patients	Retrospective case series/Combines the results of skeletally immature patients and skeletally mature patients
Aichroth 1971	Osteochondritis dissecans of the knee. A clinical survey	Less than 10 patients per Tx group

RECOMMENDATION 14

We are unable to recommend for or against physical therapy for patients with OCD treated non-operatively.

Strength of Recommendation: Inconclusive

> Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.
>
> Implications: Practitioners should feel little constraint in following a recommendation labeled as **Inconclusive,** exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

Rationale

Some skeletally immature patients with OCD of the knee and intact articular cartilage have the potential to heal non-operatively. A systematic review of the literature did not identify any studies that addressed specific physical therapy protocols for patients with OCD treated non-operatively. A period of restricted activity to reduce impact loading on the lesion and physical therapy to address impairments such as loss of motion, strength deficits, residual effusion and altered movement patterns are reported in the medical literature for patients with other conditions such as osteoarthritis (osteoarthrosis) (Please see AAOS Clinical Guideline on the Treatment of Osteoarthritis of the Knee[58]).

We were unable to find any studies that addressed these impairments or specific physical therapy protocols in patients with OCD lesions of the knee.

Supporting Evidence

There is no evidence to address this recommendation.

RECOMMENDATION 16

We are unable to recommend for or against counseling patients about whether activity modification and weight control prevents onset and progression of OCD to osteoarthritis (osteoarthrosis).

Strength of Recommendation: Inconclusive

> Description: Evidence from a single low quality study or conflicting findings that do not allow a recommendation for or against the intervention. An **Inconclusive** recommendation means that there is a lack of compelling evidence resulting in an unclear balance between benefits and potential harm.
>
> Implications: Practitioners should feel little constraint in following a recommendation labeled as **Inconclusive,** exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

Rationale

AAOS conducted a systematic review and found no evidence to support or refute this recommendation. Therefore, we are unable to recommend for or against counseling patients about whether activity modification and weight control prevents onset and progression of OCD to osteoarthritis (osteoarthrosis).

Supporting Evidence

There is no evidence to address this recommendation.

APPENDIX XV: QUALITY ASSESSMENT TABLES FOR 2023 UPDATE

Quality Assessment Tables

QE - Observational Intervention/Prognostic

Study	Patient Spectrum	Participant Recruitment	Treatment recording	Confounding Variables	Outcome measurement bias	Incomplete Outcome Data	Adequate Reporting	Strength
Ackermann, J., 2019	●	◑	○	●	●	●	●	Low Quality
Brown, M. L., 2020	●	◑	○	●	●	●	●	Low Quality
Camathias, C., 2014	●	◑	◑	●	●	●	●	Low Quality
Carey, J. L., 2020	●	◑	◑	○	●	●	●	Low Quality
Çepni, Ş 2020	●	◑	○	●	●	●	●	Low Quality
De Almeida Lira Neto, O., 2010	●	●	◑	○	◑	●	●	Low Quality
Degen, R. M., 2017	●	◑	○	◑	●	●	●	Low Quality
Figueroa, D., 2017	●	●	○	○	●	●	●	Low Quality
Gelber, P. E., 2022	●	●	●	●	●	●	●	Low Quality
Gelber, P. E., 2022	●	●	◑	●	●	●	●	Low Quality
Hevesi, M., 2018	◑	●	○	●	●	●	●	Low Quality
Husen, M., 2023	●	○	○	○	●	●	●	Low Quality
Johnson, L. L., 2014	●	●	◑	●	◑	○	●	Low Quality
Jungmann, P. M., 2019	●	◑	○	○	●	●	●	Low Quality
Kamei, G., 2012	●	●	◑	◑	●	●	●	Low Quality
Kolin, D. A., 2023	●	◑	◑	◑	●	○	●	Low Quality
Kubota, M., 2018	●	◑	○	●	●	○	●	Low Quality
León, S. A., 2019	●	◑	○	●	●	●	●	Low Quality
Oladeji, L.	●	●	●	●	●	●	●	Low

Study	Patient Spectrum	Participant Recruitment	Treatment recording	Confounding Variables	Outcome measurement bias	Incomplete Outcome Data	Adequate Reporting	Strength
O., 2017								Quality
Ramirez, A., 2010	●	◑	○	◑	●	●	●	Low Quality
Sanders, T. L., 2017	●	◑	○	●	●	●	●	Low Quality
Solheim, E., 2017	●	●	◑	●	●	●	●	Low Quality
Takigami, J., 2018	●	◑	○	●	●	●	●	Low Quality
Tírico, L. E. P., 2018	●	◑	○	●	●	●	●	Low Quality
Vasiliadis, H. S., 2010	●	◑	◑	●	●	●	●	Low Quality
Wang, K., 2020	●	◑	◑	●	●	○	●	Low Quality
Wechter, J. F., 2015	●	●	●	●	●	●	●	Low Quality
Wu, I. T., 2018	●	◑	○	○	●	●	●	Low Quality

QE - Diagnostic

Study	Patient selection bias	Index test risk of bias	Reference standard bias	Flow and timing bias	Strength
Chen, C. H., 2013	●	●	◑	●	High Quality
Ellermann, J. M., 2016	●	●	●	●	High Quality
Feroe, A. G., 2022	●	◑	◑	◑	Moderate Quality
Gans, I., 2015	●	●	◑	●	High Quality
Hancock, G. E., 2021	◑	●	○	◑	Low Quality
Heywood, C. S., 2011	○	●	○	●	Low Quality
Jungesblut, O. D., 2019	○	●	◑	●	Moderate Quality
Rocβbach, B. P., 2016	●	○	◑	●	Moderate Quality
Siegall, E., 2018	●	◑	◑	◑	Moderate Quality
Wechter, J. F., 2015	●	●	◑	●	High Quality

QE - Intervention - Randomized

Study	Random Sequence Generation	Allocation Concealment	Blinding	Incomplete Outcome Data	Selective Reporting	Other Bias	Strength
Collarile, M., 2018	●	●	○	○	●	◑	Moderate Quality
de Queiroz, A. A. B., 2018	●	●	●	●	●	●	High Quality
Kon, E., 2018	●	●	◑	●	●	◑	High Quality
Shea, K., 2021	◑	◑	○	●	●	◑	Moderate Quality
Solheim, E., 2018	●	●	○	●	●	◑	High Quality