

Diagnosis and Treatment of Osteochondritis Dissecans

Henry G. Chambers, MD
Kevin G. Shea, MD
Allen F. Anderson, MD
Tommy J. (JoJo) Brunelle, PT,
DPT
James L. Carey, MD
Theodore J. Ganley, MD
Mark V. Paterno, PT, PhD
Jennifer M. Weiss, MD
James O. Sanders, MD
William C. Watters III, MD
Michael J. Goldberg, MD
Michael W. Keith, MD
Charles M. Turkelson, PhD
Janet L. Wies, MPH
Laura Raymond, MA
Kevin M. Boyer
Kristin Hitchcock, MLS
Sara Anderson, MPH
Patrick Sluka, MPH
Catherine Boone, BS
Nilay Patel, MA

This clinical practice guideline was approved by the American Academy of Orthopaedic Surgeons on December 4, 2010.

The complete guideline, which includes all tables, figures, and appendices, is available at http://www.aaos.org/research/guidelines/OCD_guideline.pdf

J Am Acad Orthop Surg 2011;19:297-306

Copyright 2011 by the American Academy of Orthopaedic Surgeons.

Abstract

This clinical practice guideline is based on a series of systematic reviews of published studies in the available literature on the diagnosis and treatment of osteochondritis dissecans of the knee. None of the 16 recommendations made by the work group is graded as strong; most are graded inconclusive; two are graded weak; and four are consensus statements. Both of the weak recommendations are related to imaging evaluation. For patients with knee symptoms, radiographs of the joint may be obtained to identify the lesion. For patients with radiographically apparent lesions, MRI may be used to further characterize the osteochondritis dissecans lesion or identify other knee pathology.

Overview and Rationale

The American Academy of Orthopaedic Surgeons (AAOS) approved this clinical practice guideline on December 4, 2010. It is based on a systematic review of published studies on the diagnosis and treatment of osteochondritis dissecans (OCD) of the knee. The review was conducted between May 2009 and March 2010. The guideline provides practice recommendations and highlights gaps in the literature and areas that require future research.

The purpose of this clinical practice guideline is to help improve diagnosis and treatment based on the current best evidence. Current evidence-based practice standards require that physicians use the best available evidence in their clinical decision making. The AAOS clinical practice guideline process is consistent with those of other medical societies that use the highest quality evidence to make decisions about diagnosis and treatment.

This clinical practice guideline consists of a series of systematic reviews of

the available literature regarding the diagnosis and treatment of OCD of the knee. A computerized search of the electronic databases PubMed, Embase, CINAHL, and the Cochrane Library (from January 1966 to March 2010) was conducted. The search showed where good evidence exists, where evidence is lacking, and which topics future research must target to improve the treatment of patients with OCD of the knee. AAOS staff and the Diagnosis and Treatment of Osteochondritis Dissecans 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 different providers. We created this guideline as an educational tool to guide qualified physicians through a series of treatment decisions in an effort to improve the quality and efficiency of care. This guideline should not be construed as including all proper methods of care or excluding methods of care that are 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. In the era of patient-centered care, the partnership between the patient and his or her physician will be critical elements in determining the best treatment option for a condition. Treatments and procedures applicable to the individual patient rely on mutual communication between patient, physician, and other health care practitioners.

Potential Harms and Contraindications

Most treatments are associated with some known risks, especially inva-

sive and surgical treatments. In addition, contraindications vary widely based on the treatment administered. Therefore, discussion of available treatments and procedures applicable to the individual patient rely on mutual communication between the patient and physician.

Methods

The methods used to develop this clinical practice guideline were designed to combat bias, enhance transparency, and promote reproducibility. Their purpose is to allow interested readers the ability to inspect all of the information the work group used to reach all of its decisions and to verify that these decisions are in accord with the best

available evidence. The draft was subject to peer review and public commentary. It was approved by the AAOS Evidence Based Practice Committee; Guidelines and Technology Oversight Committee; Council on Research, Quality Assessment, and Technology; and the Board of Directors. The methods used to prepare this guideline are detailed in the full clinical practice guideline, available at <http://www.aaos.org/research/guidelines/OCDGuideline.asp>.

Recommendation Language

Each guideline recommendation was constructed using the following language, taking into account the recommendation grade and level of evidence:

The complete guideline, which includes all tables, figures, and appendices, is available at http://www.aaos.org/research/guidelines/OCD_guideline.pdf.

From Rady Children's Hospital, San Diego, CA (Dr. Chambers), Department of Orthopaedics, St. Luke's Children's Hospital, Boise, ID, and the University of Utah, Salt Lake City, UT (Dr. Shea), St. Thomas Hospital, Nashville, TN (Dr. Anderson), Intermountain Orthopaedics, Boise, ID (Dr. Brunelle), Vanderbilt University Hospital, Nashville, TN (Dr. Carey), Children's Hospital of Philadelphia, Philadelphia, PA (Dr. Ganley), Sports Medicine Biodynamics Center, Cincinnati Children's Hospital Medical Center, Cincinnati, OH (Dr. Paterno), Children's Hospital Los Angeles, Los Angeles, CA (Dr. Weiss), the Department of Orthopaedics and Rehabilitation, University of Rochester, Rochester, NY (Dr. Sanders), the Bone and Joint Clinic of Houston, Houston, TX (Dr. Watters), Seattle Children's Hospital, Seattle, WA (Dr. Goldberg), and the Department of Research and Scientific Affairs, American Academy of Orthopaedic Surgeons, Rosemont, IL (Dr. Turkelson, Ms. Wies, Ms. Raymond, Mr. Boyer, Ms. Hitchcock, Ms. Anderson, Mr. Sluka, Ms. Boone, and Mr. Patel). Dr. Keith is in private practice in Cleveland, OH.

Dr. Chambers or an immediate family member serves as a paid consultant to Allergan, Merz Pharmaceuticals, and OrthoPediatrics and serves as a board member, owner, officer, or committee member of the American Academy of Orthopaedic Surgeons, the American Academy for Cerebral Palsy and Developmental Medicine, and the Pediatric Orthopaedic Society of North America. Dr. Shea or an immediate family member serves as a board member, owner, officer, or committee member of the American Academy of Orthopaedic Surgeons, the American Orthopaedic Society for Sports Medicine, and the Pediatric Orthopaedic Society of North America. Dr. Anderson or an immediate family member serves as a paid consultant to OrthoPediatrics and serves as a board member, owner, officer, or committee member of the American Orthopaedic Society for Sports Medicine. Dr. Ganley or an immediate family member serves as a paid consultant to OrthoPediatrics. Dr. Weiss or an immediate family member serves as a board member, owner, officer, or committee member of the Pediatric Orthopaedic Society of North America. Dr. Sanders or an immediate family member serves as an unpaid consultant to OrthoPediatrics; has stock or stock options held in Abbott and Hospira; has received research or institutional support from Medtronic Sofamor Danek; and serves as a board member, owner, officer, or committee member of the American Academy of Orthopaedic Surgeons, the American Orthopaedic Association, the Pediatric Orthopaedic Society of North America, and the Scoliosis Research Society. Dr. Watters or an immediate family member has received royalties from Stryker; serves as a paid consultant to Stryker; has stock or stock options held in Intrinsic Orthopedics; and serves as a board member, owner, officer, or committee member of the American Board of Spine Surgery and the North American Spine Society. Dr. Goldberg or an immediate family member serves as a board member, owner, officer, or committee member of the American Academy of Orthopaedic Surgeons. Dr. Keith or an immediate family member is a member of a speakers' bureau or has made paid presentations on behalf of Synthes; serves as an unpaid consultant to Neuros; and serves as a board member, owner, officer, or committee member of the American Academy of Orthopaedic Surgeons. Ms. Wies or an immediate family member has stock or stock options held in Merck/Schering-Plough and Merck. None of the following authors nor any immediate family member has received anything of value from or owns stock in a commercial company or institution related directly or indirectly to the subject of this article: Dr. Brunelle, Dr. Carey, Dr. Paterno, Dr. Turkelson, Ms. Raymond, Mr. Boyer, Ms. Hitchcock, Ms. Anderson, Mr. Sluka, Ms. Boone, and Mr. Patel.

We recommend: Recommendation grade, Strong. Level of evidence: level I evidence from more than one study with consistent findings for recommending for or against the intervention or diagnostic.

We suggest: Recommendation grade, Moderate. Level of evidence: level II or III evidence from more than one study with consistent findings, or level I evidence from a single study for recommending for or against the intervention or diagnostic.

Option: Recommendation grade, Weak. Level of evidence: level IV evidence from more than one study with consistent findings, or level II or III evidence from a single study for recommending for or against the intervention or diagnostic. (Note: level IV evidence in this guideline does not include retrospective case series but does include retrospective comparative studies or retrospective studies that included a control group.)

We are unable to recommend for or against: Recommendation grade, Inconclusive. Level of evidence: There is insufficient or conflicting evidence not allowing a recommendation for or against intervention.

In the absence of reliable evidence, it is the *opinion* of the work group: Recommendation grade, Consensus. Level of evidence: There is no supporting evidence. In the absence of reliable evidence, the work group is making a recommendation based on their clinical opinion, considering the known harms and benefits associated with the treatment.

The recommendations are summarized in this article in Table 1.

Recommendations

Please note that, for ease of reference, we have presented the study group's recommendations by topic area. For this reason, Recommendation 9 follows Recommendation 3,

under the heading "Diagnostic Studies," below.

Diagnostic Studies

Recommendation 1

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

Strength of Recommendation: Weak. It is addressed by one level II study.

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

The AAOS conducted a systematic review that identified one diagnostic study that 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.¹

Clinical diagnosis was made on the basis of history, physical examination, and standard radiographs (ie, 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 when an MRI was performed. The clinical diagnosis (from the initial visit), MRI diagnosis (from the MRI report), and arthroscopic diagnosis (from the surgical report) were retrospectively reviewed and compared. Because only

a subset of all patients who 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. Because only a single study is available to support this recommendation, the strength of recommendation is weak.

Recommendation 2

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

Strength of Recommendation: Inconclusive.

Rationale: We were unable to find quality evidence to support or recommend against obtaining radiographs of the contralateral knee.

Recommendation 3

In a patient with a known OCD lesion on radiograph, an MRI of the knee is an option to characterize the OCD lesion or when concomitant knee pathology is suspected, such as meniscal pathology, anterior cruciate ligament injury, or articular cartilage injury.

Strength of Recommendation: Weak. It is addressed by two level II studies.

Rationale: The AAOS conducted a systematic review that identified two diagnostic studies^{1,2} 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.¹ The clinical diagnosis (from the initial visit), MRI diagnosis (from the MRI report), and the arthroscopic diagnosis (from the surgical report) were

Table 1

Summary of Recommendations

Recommendation	Summary	Strength of Recommendation
1.	In a patient with knee symptoms (pain, swelling, locking, catching, popping, giving way) and/or signs (tenderness, effusion, loss of motion, crepitus), radiographs (including AP, lateral, sunrise/Merchant, and tunnel views) are an option.	Weak
2.	We are unable to recommend for or against radiographs on the contralateral asymptomatic knee in patients with confirmed OCD of one knee.	Inconclusive
3.	In a patient with a known OCD lesion on radiograph, 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.	Weak
4.	We are unable to recommend for or against nonsurgical treatment (casting, bracing, splinting, unloader brace, electrical or ultrasound bone stimulators, or activity restriction alone) for <i>asymptomatic</i> skeletally immature patients with OCD.	Inconclusive
5.	We are unable to recommend for or against a specific nonsurgical treatment (casting, bracing, splinting, unloader brace, electrical or ultrasound bone stimulators, or activity restriction alone) for <i>symptomatic</i> skeletally immature patients with OCD.	Inconclusive
6.	We are unable to recommend for or against arthroscopic drilling in <i>symptomatic</i> skeletally immature patients with a stable lesion(s) who have failed to heal with nonsurgical treatment of ≥ 3 months.	Inconclusive
7.	In the absence of reliable evidence, it is the opinion of the work group that <i>symptomatic</i> skeletally immature patients with salvageable unstable or displaced OCD lesions be offered the option of surgery.	Consensus
8.	We are unable to recommend for or against a specific cartilage repair technique in <i>symptomatic</i> skeletally immature patients with unsalvageable fragment.	Inconclusive
9.	We are unable to recommend for or against repeat MRI for <i>asymptomatic</i> skeletally mature patients.	Inconclusive
10.	We are unable to recommend for or against treating asymptomatic skeletally mature patients with OCD progression (as identified by radiograph or MRI) as symptomatic skeletally mature patients are treated.	Inconclusive
11.	In the absence of reliable evidence, it is the opinion of the work group that <i>symptomatic</i> skeletally mature patients with salvageable unstable or displaced OCD lesions be offered the option of surgery.	Consensus
12.	We are unable to recommend for or against a specific cartilage repair technique in <i>symptomatic</i> skeletally mature patients with an unsalvageable OCD lesion.	Inconclusive
13.	In the absence of reliable evidence, it is the opinion of the work group that patients who remain symptomatic after treatment of OCD have a history and physical examination, radiographs, and/or MRI to assess healing.	Consensus
14.	We are unable to recommend for or against physical therapy for patients with OCD treated nonsurgically.	Inconclusive
15.	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 postoperative physical therapy.	Consensus
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 (ie, osteoarthrosis).	Inconclusive

ACL = anterior cruciate ligament, OCD = osteochondritis dissecans

retrospectively reviewed and compared. Because only a subset of all patients who 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 stan-

dard was evaluated as a level II study.

Similarly, the second diagnostic study identified in the systematic review prospectively evaluated all con-

secutive patients undergoing knee arthroscopy who had a preoperative MRI.² Again, this study reports only on the subset of patients who 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 was 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 radiography 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 radiograph. That is, these studies do not compare the diagnostic performance of clinical examination with standard radiographs to a clinical examination with standard radiographs and an MRI; therefore, we downgraded the strength of this recommendation to weak.

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 to guide therapeutic decision making. Of the five therapeutic studies included in the development of this guideline,³⁻⁷ three report the acquisition of an MRI at enrollment,^{3,5} and three report the acquisition of an MRI at follow-up evaluation.^{3,5,6} Further, one prognostic study predicts the healing potential of stable OCD lesions, using a multivariable logistic regression model.⁸ Of all of the variables that were considered (including sex, side, location, symptoms, knee dimensions, and lesion dimensions), only knee symptoms and normalized length and normalized width of the

OCD lesion as measured on MRI were found to be predictive of healing potential.

Of note, three studies⁹⁻¹¹ 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.

Recommendation 9

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

Strength of Recommendation: Inconclusive.

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.

Treatment Options: Skeletally Immature

Recommendation 4

We are unable to recommend for or against nonsurgical treatment (ie, 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.

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

Recommendation 5

We are unable to recommend for or against a specific nonsurgical treatment (ie, casting, bracing, splinting, unloader brace, electrical or ultrasound bone stimulators, activity restriction alone) for symptomatic

skeletally immature patients with OCD.

Strength of Recommendation: Inconclusive.

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

Recommendation 6

We are unable to recommend for or against arthroscopic drilling in symptomatic skeletally immature patients with a stable lesion or stable lesions who have failed to heal with nonsurgical treatment of at least 3 months.

Strength of Recommendation: Inconclusive.

Rationale: The 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.

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

Recommendation 7

In the absence of reliable evidence, it is the opinion of the work group that symptomatic, skeletally immature patients with salvageable unstable or displaced OCD lesions be offered the option of surgery.

Strength of Recommendation: Consensus.

Rationale: Children who are skeletally immature (ie, 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 when 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 (ie, osteoarthrosis) at an early age. Although the exact degree of risk is not known, the work group deemed that it is 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, that of irreversible osteoarthritis/osteoarthrosis. This latter risk is of particular concern because effective treatments of young patients with severe osteoarthritis (ie, 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 (ie, os-

teoarthrosis). 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 sufficient information about surgery to allow their making a sound judgment about whether to proceed to surgery given each patient’s individual situation.

The present recommendation does not apply to all patients with OCD. In many skeletally immature children (ie, 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.

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.

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 because many applicable outcomes and techniques were not addressed, the results of this single study were evaluated as inconclusive.

Supporting Evidence: The AAOS

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

The term chondroplasty was included to keep the search inclusive and possibly include 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 (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)³ (Table 1, available in the full clinical practice guideline, available at <http://www.aaos.org/research/guidelines/OCDGuideline.asp>). This study reported the International Cartilage Repair Society (ICRS) score, 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 to 48 months following treatment, as well as a greater percentage of patients returned to their preinjury level of activities of daily living, compared with patients treated with microfracture. 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 that patients treated with OAT had statistically significantly more crepitus than did patients treated with microfrac-

ture, but AAOS calculations cannot confirm these results.

Treatment Options: Skeletally Mature

Recommendation 10

We are unable to recommend for or against treating asymptomatic, skeletally mature patients with OCD progression (as identified by radiograph or MRI) as symptomatic, skeletally mature patients are treated.

Strength of Recommendation: Inconclusive.

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

Recommendation 11

In the absence of reliable evidence, it is the opinion of the work group that symptomatic, skeletally mature patients with salvageable unstable or displaced OCD lesions be offered the option of surgery.

Strength of Recommendation: Consensus.

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 (ie, osteoarthrosis) at an early age. Although the exact degree of risk is not known, the work group deemed that it is 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, that of irreversible osteoarthritis/osteoarthrosis. This latter risk is of particular concern since effective treatments of young patients with severe osteoarthritis (ie, 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 (ie, 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 sufficient information about surgery to allow their making a sound judgment about whether to proceed to surgery given each pa-

tient’s individual situation.

The present recommendation does not apply to all patients with OCD. In many skeletally immature children (ie, 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.

Recommendation 12

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

Strength of Recommendation: Inconclusive.

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. Four level IV studies addressed cartilage repair techniques for an unsalvageable OCD lesion. Because each of these level IV studies used different techniques, different outcome measures, and differing lengths of follow-up, the work group deemed that the evidence for any specific technique was inconclusive.

Surveillance, Rehabilitation, and Prevention

Recommendation 13

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

Strength of Recommendation: Consensus.

Rationale: We suspect that patients with OCD have a risk of developing severe osteoarthritis (ie, osteoarthrosis) at a young age. The treatment options for these young patients with osteoarthritis (ie, osteoarthrosis) are limited and, therefore, the quality of life of these patients is significantly affected. 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 who 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 on the patient's symptoms and signs and on imaging to detect possible deterioration. Recognition and intervention allowing treatment of lesions at early stages may improve outcomes and prevent sequelae (eg, severe osteoarthritis [ie, 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.

Recommendation 14

We are unable to recommend for or against physical therapy for patients with OCD treated nonsurgically.

Strength of Recommendation: Inconclusive.

Rationale: Some skeletally immature patients with OCD of the knee

and intact articular cartilage have the potential to heal nonsurgically. A systematic review of the literature did not identify any studies that addressed specific physical therapy protocols for patients with OCD treated nonsurgically. 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 (ie, osteoarthrosis). (Please see the AAOS Clinical Guideline, *Treatment of Osteoarthritis of the Knee [Non-Arthroplasty]*).¹²

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

Recommendation 15

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 postoperative physical therapy.

Strength of Recommendation: Consensus.

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 postoperative 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 their patients received postoperative physical therapy evaluated the effects of that therapy^{3,5-7,13-16}) 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.

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 (ie, osteoarthrosis).

Strength of Recommendation: Inconclusive.

Rationale: The 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 activity modification and weight control.

Future Research

Although OCD was identified more than 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.^{1-11,13-17}

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

1. Inter- and intraobserver reliability studies should be conducted on critical observations used in diagnosing and characterizing OCD lesions. These critical observations include the radiographic (ie, radiography, 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 nonsurgically should be conducted to identify the independent predictors of success of nonsurgical management of an OCD lesion. These independent predictors may be historical information (eg, age, mechanical symptoms), physical examination findings (eg, effusion, point tenderness), or radiographic features (eg, 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 nonsurgical 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, in patients with stable lesions that are predicted to heal, therapy and exercise modalities of 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 nonsurgical 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 nonsurgical treatment may be studied using a randomized study design that compares anterograde to retrograde drilling. Alternatively, patients with unstable lesions may be studied using a randomized study design that compares fixation with minifragment 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 postoperative 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, compared, evaluated, and validated according to the most important criteria for the diagnosis of OCD. Identifying a reliable classification system could help standardize diagnoses and corresponding treatment and establish the true incidence and prevalence of this disease in children and adults.

Because OCD is a rare condition, many of these trials will need to be designed and conducted as multi-

center studies. Multicenter studies allow for faster enrollment of an adequate sample size. In addition, a multicenter design may improve external validity.

References

1. Kocher MS, DiCanzio J, Zurakowski D, Micheli LJ: Diagnostic performance of clinical examination and selective magnetic resonance imaging in the evaluation of intraarticular knee disorders in children and adolescents. *Am J Sports Med* 2001;29(3):292-296.
2. Luhmann SJ, Schootman M, Gordon JE, Wright RW: Magnetic resonance imaging of the knee in children and adolescents: Its role in clinical decision-making. *J Bone Joint Surg Am* 2005;87(3):497-502.
3. Gudas R, Simonaityte R, Cekanauskas E, Tamosiunas R: A prospective, randomized clinical study of osteochondral autologous transplantation versus microfracture for the treatment of osteochondritis dissecans in the knee joint in children. *J Pediatr Orthop* 2009;29(7):741-748.
4. Pascual-Garrido C, Friel NA, Kirk SS, et al: Midterm results of surgical treatment for adult osteochondritis dissecans of the knee. *Am J Sports Med* 2009;37(suppl 1):125S-130S.
5. Peterson L, Minas T, Brittberg M, Lindahl A: Treatment of osteochondritis dissecans of the knee with autologous chondrocyte transplantation: Results at two to ten years. *J Bone Joint Surg Am* 2003;85(suppl 2):17-24.
6. Steinhagen J, Bruns J, Deuretzbacher G, Ruether W, Fuerst M, Niggemeyer O: Treatment of osteochondritis dissecans of the femoral condyle with autologous bone grafts and matrix-supported autologous chondrocytes. *Int Orthop* 2010;34(6):819-825.
7. Ossendorf C, Kreuz PC, Steinwachs MR, Erggelet C: Autologous chondrocyte implantation for the treatment of large full-thickness cartilage lesions of the knee. *Saudi Med J* 2007;28(8):1251-1256.
8. Wall EJ, Vourazeris J, Myer GD, et al: The healing potential of stable juvenile osteochondritis dissecans knee lesions. *J Bone Joint Surg Am* 2008;90(12):2655-2664.
9. De Smet AA, Fisher DR, Graf BK, Lange RH: Osteochondritis dissecans of the knee: Value of MR imaging in determining lesion stability and the

presence of articular cartilage defects. *AJR Am J Roentgenol* 1990;155(3):549-553.

10. Kijowski R, Blankenbaker DG, Shinki K, Fine JP, Graf BK, De Smet AA: Juvenile versus adult osteochondritis dissecans of the knee: Appropriate MR imaging criteria for instability. *Radiology* 2008; 248(2):571-578.

11. O'Connor MA, Palaniappan M, Khan N, Bruce CE: Osteochondritis dissecans of the knee in children: A comparison of MRI and arthroscopic findings. *J Bone Joint Surg Br* 2002;84(2):258-262.

12. American Academy of Orthopaedic Surgeons: Clinical Practice Guideline: *Treatment of Osteoarthritis of the Knee (Non-Arthroplasty)*. Approved December 6, 2008. Available at: http://www.aaos.org/research/guidelines/OCD_guideline.pdf. Accessed March 11, 2011.

13. Kocher MS, Micheli LJ, Yaniv M, Zurakowski D, Ames A, Adrignolo AA: Functional and radiographic outcome of juvenile osteochondritis dissecans of the knee treated with transarticular arthroscopic drilling. *Am J Sports Med* 2001;29(5):562-566.

14. Hayan R, Phillippe G, Ludovic S, Claude K, Jean-Michel C: Juvenile osteochondritis of femoral condyles: Treatment with transchondral drilling: Analysis of 40 cases. *J Child Orthop* 2009.

15. Kocher MS, Czarnecki JJ, Andersen JS, Micheli LJ: Internal fixation of juvenile osteochondritis dissecans lesions of the knee. *Am J Sports Med* 2007;35(5):712-718.

16. Weckström M, Parviainen M, Kiuru MJ, Mattila VM, Pihlajamäki HK: Comparison of bioabsorbable pins and nails in the fixation of adult osteochondritis dissecans fragments of the knee: An outcome of 30 knees. *Am J Sports Med* 2007;35(9):1467-1476.

17. Cahill BR, Phillips MR, Navarro R: The results of conservative management of juvenile osteochondritis dissecans using joint scintigraphy: A prospective study. *Am J Sports Med* 1989;17(5):601-605.