Complete Summary

GUIDELINE TITLE

Avascular necrosis of the hip.

BIBLIOGRAPHIC SOURCE(S)

DeSmet AA, Dalinka MK, Alazraki NP, Daffner RH, El-Khoury GY, Kneeland JB, Manaster BJ, Pavlov H, Rubin DA, Steinbach LS, Weissman BN, Haralson RH III, Expert Panel on Musculoskeletal Imaging. Avascular necrosis of the hip. [online publication]. Reston (VA): American College of Radiology (ACR); 2005. 8 p. [59 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: DeSmet AA, Dalinka MK, Alazraki N, Berquist TH, Daffner RH, el-Khoury GY, Goergen TG, Keats TE, Manaster BJ, Newberg A, Pavlov H, Haralson RH, McCabe JB, Sartoris D. Diagnostic imaging of avascular necrosis of the hip. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):247-54.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

Avascular necrosis of the hip

GUIDELINE CATEGORY

Diagnosis

CLINICAL SPECIALTY

Emergency Medicine
Internal Medicine
Nuclear Medicine
Orthopedic Surgery
Radiology

INTENDED USERS

Health Plans
Hospitals
Managed Care Organizations
Physicians
Utilization Management

GUIDELINE OBJECTIVE(S)

To evaluate the appropriateness of initial radiologic examinations for avascular necrosis of the hip

TARGET POPULATION

- Patients suspected of avascular necrosis of the hip
- Patients with avascular necrosis of the hip

INTERVENTIONS AND PRACTICES CONSIDERED

1. X-ray
    - Anteroposterior pelvis (AP) radiograph
    - Frogleg lateral radiograph of the hip(s)
    - Cross-table lateral radiograph of the hip(s)
2. Computed tomography (CT)
    - Axial images only
    - Axial plus coronal and sagittal reformatted images
3. Radionuclide bone scan
4. Magnetic resonance imaging (MRI)
5. Magnetic resonance imaging with and without contrast
6. Nuclear medicine (NUC), bone scan
7. Planar plus single photon emission computed tomography (SPECT), bone scan

MAJOR OUTCOMES CONSIDERED

Utility of radiologic examinations in differential diagnosis

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The guideline developer performed literature searches of peer-reviewed medical journals, and the major applicable articles were identified and collected.

NUMBER OF SOURCE DOCUMENTS

The total number of source documents identified as the result of the literature search is not known.

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Not Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not stated

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

One or two topic leaders within a panel assume the responsibility of developing an evidence table for each clinical condition, based on analysis of the current literature. These tables serve as a basis for developing a narrative specific to each clinical condition.

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus (Delphi)

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Since data available from existing scientific studies are usually insufficient for meta-analysis, broad-based consensus techniques are needed for reaching agreement in the formulation of the appropriateness criteria. The American College of Radiology (ACR) Appropriateness Criteria panels use a modified Delphi technique to arrive at consensus. Serial surveys are conducted by distributing questionnaires to consolidate expert opinions within each panel. These questionnaires are distributed to the participants along with the evidence table

and narrative as developed by the topic leader(s). Questionnaires are completed by the participants in their own professional setting without influence of the other members. Voting is conducted using a scoring system from 1 to 9, indicating the least to the most appropriate imaging examination or therapeutic procedure. The survey results are collected, tabulated in anonymous fashion, and redistributed after each round. A maximum of three rounds is conducted and opinions are unified to the highest degree possible. Eighty (80) percent agreement is considered a consensus. This modified Delphi technique enables individual, unbiased expression, is economical, easy to understand, and relatively simple to conduct.

If consensus cannot be reached by this Delphi technique, the panel is convened and group consensus techniques are utilized. The strengths and weaknesses of each test or procedure are discussed and consensus reached whenever possible. If "No consensus" appears in the rating column, reasons for this decision are added to the comment sections.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

ACR Appropriateness Criteria®

Clinical Condition: Unilateral or Bilateral Hip Pain

Variant 1: Initial study when avascular necrosis suspected clinically.

Radiologic Exam Procedure	Appropriateness Rating	Comments
X-ray, pelvis, AP	9	Essential for initial evaluation in

Radiologic Exam Procedure	Appropriateness Rating	Comments
		patients at risk for AVN who present with hip pain.
X-ray, hips, frogleg lateral	9	Frogleg view is necessary to evaluate anterosuperior involvement of the femoral head.
X-ray, hips, Cross-table lateral	1	Poor detail due to overlapping soft tissues limits usefulness.
CT, hips	1	Not useful for initial evaluation.
NUC, bone scan	1	Sensitive method for detection of AVN, but not indicated before radiographs.
MRI, hips	1	Most sensitive method for detection of AVN, but not indicated before radiographs.
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Avascular necrosis with femoral head collapse by radiographs in the painful hip: no surgery contemplated at this time.

Radiologic Exam Procedure	Appropriateness Rating	Comments
MRI, hip	3	May be useful if knowledge of occult AVN in the opposite hip is needed.
NUC, bone scan	1	May be useful if knowledge of occult AVN in the opposite hip is needed and magnetic resonance is not available.
NUC, bone scan, Planar plus single photon emission computed tomography (SPECT)	1	May be useful if knowledge of occult AVN in the opposite hip is needed and magnetic resonance is not available.
CT, hip, axial images only	1	Provides no more information than conventional radiographs
CT, hip, axial plus coronal and sagittal	1	May be useful if planning osteotomy by defining anatomic localization of the

Radiologic Exam Procedure	Appropriateness Rating	Comments
reformatted images		AVN and the extent of bone deformity.
MRI, hip, with and without contrast	1	Assessment of perfusion is not needed.
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Avascular necrosis with femoral head collapse by radiographs in the painful hip: surgery contemplated.

Radiologic Exam Procedure	Appropriateness Rating	Comments
MRI, hip	5	May be useful if knowledge of occult AVN in the opposite hip is needed.
NUC, bone scan	1	May be useful if knowledge of occult AVN in the opposite hip is needed and magnetic resonance is not available.
NUC, bone scan, Planar plus single photon emission computed tomography (SPECT)	1	May be useful if knowledge of occult AVN in the opposite hip is needed and magnetic resonance is not available.
CT, hip, axial images only	1	Provides no more information than conventional radiographs.
CT, hip, axial plus coronal and sagittal reformatted images	1	May be useful if planning osteotomy by defining anatomic localization of the AVN and the extent of bone deformity.
MRI, hip with and without contrast	1	Assessment of perfusion is not needed.
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Radiograph shows mottled femoral head, suspicious but not definite for avascular necrosis in the painful hip(s). Further clinical evaluation is needed.

Radiologic Exam Procedure	Appropriateness Rating	Comments
MRI, hip	9	MRI provides definitive diagnosis when radiograph findings are equivocal.
NUC, bone scan	1	Indicated if MRI is not available.
NUC, bone scan, Planar plus SPECT	1	Indicated if MRI is not available.
CT, hip, axial images only	1	Less sensitive than bone scanning or MRI.
CT, hip, axial plus coronal and sagittal reformatted images	1	Less sensitive than bone scanning or MRI.
MRI, hip with and without contrast	1	Assessment of perfusion is not needed.
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 5: Avascular necrosis suspected clinically but radiographs are normal. Further clinical evaluation needed.

Radiologic Exam Procedure	Appropriateness Rating	Comments
MRI, hip	9	Most sensitive and specific method to establish or exclude AVN.
NUC bone scan	1	Might be indicated if MRI is not available or MR is negative and AVN is still suspected.
NUC, bone scan, Planar plus SPECT	1	Might be indicated if MRI is not available or MR is negative and AVN is still suspected.
CT, hip, axial images only	1	Not as sensitive as bone scan or MRI.
CT, hip, axial plus	1	Not as sensitive as bone scan or MRI.

Radiologic Exam Procedure	Appropriateness Rating	Comments
coronal and sagittal reformatted images		
MRI, hip with and without contrast	1	Assessment of perfusion is not needed.
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 6: Displaced or nondisplaced femoral neck fracture on radiographs.

Radiologic Exam Procedure	Appropriateness Rating	Comments
NUC, bone scan	1	Not needed for clinical management and not predictive of later AVN.
NUC, bone scan, Planar plus SPECT	1	Not needed for clinical management and not predictive of later AVN.
CT, hip, axial images only	1	Not needed for clinical management and not predictive of later AVN.
CT, hip, axial plus coronal and sagittal reformatted images	1	Not needed for clinical management and not predictive of later AVN.
MRI, hip	1	Not needed for clinical management and not predictive of later AVN.
MRI, hip with and without contrast	1	If MRI were to be proven to accurately predict the femoral heads that go on to collapse, evaluation of perfusion may be useful before surgery.
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Avascular necrosis (AVN) is a relatively common disease in which there is death of the cellular elements of bone or marrow. The femoral heads are the most

commonly affected sites for clinically significant AVN. There are numerous predisposing causes, including dislocation of the hip, femoral neck fracture, corticosteroid usage, collagen vascular disease, and the hemoglobinopathies. Femoral head AVN is a significant problem in healthcare because it often affects young adults. With secondary collapse of the femoral head, disabling hip pain may result in the need for total joint replacement in early adulthood. For nontraumatic causes of AVN, the disease is often bilateral, which further increases the extent of disability.

There are no specific physical findings or laboratory tests to establish the diagnosis of AVN. Clinically suspected AVN can be confirmed only by diagnostic imaging or biopsy. Imaging methods for definitive diagnosis include radiographs, conventional tomography, computed tomography (CT), radionuclide bone scans, and magnetic resonance imaging (MRI). These methods vary considerably in their cost, diagnostic accuracy, and the information provided. The importance of these methods for diagnosis of AVN is directly related to the influence of early diagnosis on patient outcome. Core decompression of an avascular femoral head has been proposed as a method to reduce the likelihood of subsequent femoral head collapse. This technique has shown good results in some series but not in others. A study of 18 patients with early AVN by radiographs found that core decompression was associated with a better outcome if the area of involvement measured by MRI was small. Other techniques have been recommended for treatment of AVN of the femoral head, including free bone grafts, vascularized bone grafts, osteochondral allografts, osteotomy, and electrical stimulation. More studies are needed to determine the long-term benefits of the many procedures that are used to treat AVN of the femoral head. While the optimal treatment is still debated, early diagnosis and staging of AVN are important for two reasons. First, establishing that AVN is the cause for a patient's hip pain allows exclusion of conditions such as infection, neoplasm, or occult fracture that require early specific treatment. Second, accurate diagnosis and staging of AVN will be essential in assessing the efficacy of any treatment developed in the future.

Radiographs are the least expensive and most widely available imaging technology. Radiographs should be obtained as the initial study in every patient suspected with AVN. In the presence of AVN, the radiograph findings may be normal, abnormal or nonspecific. Although the radiograph findings for AVN of the femoral head are well known, there are no studies that determine the diagnostic efficacy of individual radiographic views. Most authorities believe that both anteroposterior and frogleg lateral views are necessary because a subchondral fracture or cortical depression may be seen only on one of the two views. Although anecdotal examples of the value of tomography have been presented, no study has been performed to determine the sensitivity or specificity of tomography for the diagnosis of AVN.

Computed tomography with multiplanar reconstruction is less sensitive than bone scanning and MRI in the diagnosis of AVN with an accuracy comparable or superior to that of radiographs. Its major role is in determining the severity of secondary degenerative joint disease or the extent of collapse of the femoral head. This information is useful in surgical planning for either osteotomy or joint replacement. In addition, CT has been shown to be more sensitive than radiography and MRI in the detection of subchondral fractures.

For the detection of radiographically occult AVN, radionuclide bone scanning and MRI are both sensitive methods. However, MRI is preferred because it has greater sensitivity and a greater specificity than bone scanning. The sensitivity for detection of AVN has ranged from 88%-100% for MRI and from 72%-87% for radionuclide bone scanning. The addition of single-photon-emission computed tomography (SPECT) improves the accuracy of radionuclide imaging for the diagnosis of AVN, with MRI found to be more accurate than SPECT in one study but SPECT more accurate than MRI in another. One potential cause for incorrect diagnosis of AVN by MRI is transient osteoporosis, but attention to the MRI findings will usually allow differentiation of these two entities. MRI has a second advantage over bone scanning, because the MRI findings of AVN are usually characteristic, which allows differentiation from other hip diseases. There are occasional cases of AVN with normal radiographs in which either bone scanning or MRI may be falsely negative. In these cases, both studies might be performed. Although MRI costs more than radionuclide bone scanning, a limited MRI examination may permit the diagnosis of AVN at a lower cost.

The indications for which diagnostic modalities to use vary depending on the clinical situation. In the typical patient presenting with hip pain, there have been no studies to indicate that MRI should be used routinely to detect occult AVN. Because of the large number of patients who have bursitis or osteoarthritis, it would not be cost effective to obtain an MRI on every patient presenting with hip pain.

A less clear situation is when the patient is being treated with high-dose corticosteroids. These patients are at a high risk for development of AVN, and MRI is commonly recommended if they develop hip pain. There have also been studies evaluating MRI or radionuclide bone scanning in patients without hip pain who are at high risk for AVN. Patients who are on corticosteroids for renal transplants were found to have a high incidence of AVN despite the absence of hip pain. MRI shows typical changes of AVN in 6%-22% of these asymptomatic patients. In a well controlled prospective study of 104 patients who had renal transplants, 14 patients developed MRI evidence of AVN. Four of these patients subsequently developed pain with collapse of the femoral heads and ultimately required hip arthroplasty. The other 10 patients remained asymptomatic; the MRI returned to normal in five patients. Similarly, in a prospective study of 23 patients on corticosteroids for systemic lupus erythematosus, MRI findings of AVN were noted in 12 (52%) of the 23 patients; three patients subsequently developed hip pain. In another study of patients with systemic lupus erythematosus, 24 asymptomatic hips where found to have AVN on MRI with only four hips showing worsening on follow-up MRI. It is clear that MRI can detect AVN in these high-risk, asymptomatic patients. Because of the variability in development of later symptoms, the difficulty has been in deciding in which patients early intervention may be useful. Several studies have found that the extent of involvement of the femoral head on MRI predicts subsequent bone collapse. These studies would suggest that early intervention should be considered in patients who have involvement of a large portion of the apex of the femoral head. Certainly, future studies evaluating treatment of AVN to prevent collapse should include pretreatment MRI evaluation of the extent of disease. The current literature suggests that core decompression should be performed only when the area of involvement as measured by MRI is small. However, patients with a small area of involvement are more likely to have a good outcome even without intervention.

A second clinical consideration is the risk of developing AVN in patients who have acute femoral neck fractures. Most patients with minimally displaced femoral neck fractures are treated empirically with internal fixation. With markedly displaced fractures, femoral head replacement is usually performed because of the increased risk of fracture nonunion and avascular necrosis. There may be a role for diagnostic imaging in determining which femoral heads are avascular after fracture. If the femoral head is still vascularized, internal fixation might be an alternative to femoral head replacement. If the head were avascular, femoral head replacement could be done immediately. Neither conventional MRI nor radionuclide bone scanning is effective in evaluating the vascular perfusion of the femoral head in the 48-hour period after development of ischemia. However, MRI after gadolinium injection accurately assessed femoral head vascularity both in a dog model of acute AVN and in a study of 13 humans with acute femoral neck fractures. This assessment should be confirmed in a controlled study before it can be routinely recommended. Serial MRI after fixation of femoral neck fractures was shown to be useful in the prediction of development of AVN, but this has been noted in only one study.

In summary, the following guidelines are proposed. When a patient who is at high risk for avascular necrosis develops hip pain, the initial examination should consist of an anteroposterior pelvis and frogleg lateral radiograph of the symptomatic hip. If the radiograph findings are definite for avascular necrosis, an MRI might be indicated only if knowledge of asymptomatic AVN in the opposite hip is clinically important. If the radiograph findings are equivocal for AVN or are normal in the symptomatic hip, then MRI is necessary to confirm the diagnosis of avascular necrosis and to exclude other causes for the patient's hip pain. In patients in whom MRI cannot be performed, a bone scan with SPECT imaging is a reasonable alternative for the diagnosis of radiographically occult AVN. Screening of the patient who is at high risk for AVN may be of value only if prophylactic treatment of asymptomatic AVN is proven useful. The use of MRI with gadolinium enhancement is currently of unproven value in managing patients with acute hip fractures.

Anticipated Exceptions

Clinical factors will certainly play a role in altering the necessity of diagnostic imaging. If the patient at high risk for AVN has equivocal radiographic findings for AVN, those findings may be adequate for clinical management if the pain is mild and there are no laboratory or clinical findings to suggest underlying infection, tumor, or occult fracture. If the patient with hip pain and at risk for AVN has a normal radiograph, the radiograph alone may be adequate if the clinical findings suggest a condition such as bursitis. In the future, interventional treatment may be developed that significantly reduces the risk of femoral head collapse in the patient with early AVN. If so, screening of asymptomatic patients at high risk for AVN may become clinically appropriate.

Abbreviations

- AP, anteroposterior pelvis
- CT, computed tomography
- MRI, magnetic resonance imaging
- NUC, nuclear medicine

- SPECT, single photon emission computed tomography

CLINICAL ALGORITHM(S)

Algorithms were not developed from criteria guidelines.

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The recommendations are based on analysis of the current literature and expert panel consensus.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Appropriate selection of radiologic exam procedures to evaluate patients with or suspected to have avascular necrosis of the hip

POTENTIAL HARMS

Not stated

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

An American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Personal Digital Assistant (PDA) Downloads

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Living with Illness

IOM DOMAIN

Effectiveness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

DeSmet AA, Dalinka MK, Alazraki NP, Daffner RH, El-Khoury GY, Kneeland JB, Manaster BJ, Pavlov H, Rubin DA, Steinbach LS, Weissman BN, Haralson RH III, Expert Panel on Musculoskeletal Imaging. Avascular necrosis of the hip. [online publication]. Reston (VA): American College of Radiology (ACR); 2005. 8 p. [59 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1995 (revised 2005)

GUIDELINE DEVELOPER(S)

American College of Radiology - Medical Specialty Society

SOURCE(S) OF FUNDING

American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

GUIDELINE COMMITTEE

Committee on Appropriateness Criteria, Expert Panel on Musculoskeletal Imaging

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Panel Members: Arthur A. De Smet, MD; Murray K. Dalinka, MD; Naomi P. Alazraki, MD; Richard H. Daffner, MD; George Y. El-Khoury, MD; John B. Kneeland, MD; B.J. Manaster, MD, PhD; Helene Pavlov, MD; David A. Rubin, MD; Lynne S. Steinbach, MD; Barbara N. Weissman, MD; Robert H. Haralson III, MD

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

This is the current release of the guideline.

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The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

ACR Appropriateness Criteria® *Anytime*, *Anywhere*™ (PDA application). Available from the ACR Web site.

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

AVAILABILITY OF COMPANION DOCUMENTS

The following is available:

- ACR Appropriateness Criteria®. Background and development. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable

Document Format (PDF) from the American College of Radiology (ACR) Web site.

PATIENT RESOURCES

None available

NGC STATUS

This summary was completed by ECRI on May 6, 2001. The information was verified by the guideline developer as of June 29, 2001. The NGC summary was updated by ECRI on January 27, 2006.

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