

Recognizing
The National
Bone and Joint Decade
2002–2011

*Questions
& Answers*
about . . .

Osteonecrosis
(Avascular Necrosis)

*National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS)
National Institutes of Health
Public Health Service • U.S. Department of Health and Human Services*

For Your Information

This publication contains information about medications used to treat the health condition discussed here. When this booklet was printed, we included the most up-to-date (accurate) information available. Occasionally, new information on medication is released.

For updates and for any questions about any medications you are taking, please contact the U.S. Food and Drug Administration at 1-888-INFO-FDA (1-888-463-6332, a toll-free call) or visit their Web site at www.fda.gov.

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1 AMS Circle

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What Is Osteonecrosis?

Osteonecrosis is a disease resulting from the temporary or permanent loss of blood supply to the bones. Without blood, the bone tissue dies, and ultimately the bone may collapse. If the process involves the bones near a joint, it often leads to collapse of the joint surface. Osteonecrosis is also known as avascular necrosis, aseptic necrosis, and ischemic necrosis.

Although it can happen in any bone, osteonecrosis most commonly affects the ends (epiphysis) of the femur, the bone extending from the knee joint to the hip joint. Other common sites include the upper arm bone, knees, shoulders, and ankles. The disease may affect just one bone, more than one bone at the same time, or more than one bone at different times. According to the American Academy of Orthopaedic Surgeons, 10,000 to 20,000 people develop osteonecrosis each year, and most of them are between 20 and 50 years of age. Osteonecrosis is the underlying diagnosis in approximately 10 percent of hip replacements. Orthopaedists – doctors who specialize in the diagnosis and treatment of injuries and diseases of the musculoskeletal system – most often diagnose this disease.

The amount of disability that results from osteonecrosis depends on what part of the bone is affected, how large an area is involved, and how effectively the bone rebuilds itself. Normally, bone continuously breaks down and rebuilds – old bone is replaced with new bone. This process – which takes

place after an injury as well as during normal growth – keeps the skeleton strong and helps it to maintain a balance of minerals. In the course of osteonecrosis, however, the healing process is usually ineffective and the bone tissues break down faster than the body can repair them. If left untreated, the disease progresses, the bone collapses, and the joint surface breaks down, leading to pain and arthritis.

What Causes Osteonecrosis?

Osteonecrosis is caused by impaired blood supply to the bone, but it is not always clear what causes that impairment. Osteonecrosis often occurs in people with certain risk factors (such as high-dose corticosteroid use and excessive alcohol intake) and medical conditions. However, it also affects people with no health problems and for no known reason. Following are some potential causes of osteonecrosis and other health conditions associated with its development.

Steroid Medications

Aside from injury, one of the most common causes of osteonecrosis is the use of corticosteroid medications such as prednisone. Corticosteroids are commonly used to treat inflammatory diseases such as systemic lupus erythematosus, rheumatoid arthritis, inflammatory bowel disease, severe asthma, and vasculitis. Studies suggest that long-term use of oral or intravenous (IV) corticosteroids is associated with

nontraumatic osteonecrosis. Patients should discuss concerns about steroid use with their doctor.

Doctors are not sure exactly why the use of corticosteroids sometimes leads to osteonecrosis. They speculate that the drugs may interfere with the body's ability to break down fatty substances called lipids. These substances then build up in and clog the blood vessels, causing them to narrow and to reduce the amount of blood that gets to the bone. Some studies suggest that corticosteroid-related osteonecrosis is more severe and more likely to affect both hips (when occurring in the hip) than osteonecrosis resulting from other causes.

Alcohol Use

Excessive alcohol use is another common cause of osteonecrosis. People who drink alcohol in excess can develop fatty substances that may block blood vessels, causing a decreased blood supply to the bones.

Injury

When a fracture, a dislocation, or some other joint injury occurs, the blood vessels may be damaged. This can interfere with the blood circulation to the bone and lead to trauma-related osteonecrosis. In fact, studies suggest that hip dislocation and hip fractures are major risk factors for osteonecrosis.

Increased pressure within the bone may be another cause of osteonecrosis. When there is too much pressure within the

bone, the blood vessels narrow, making it hard for them to deliver enough blood to the bone cells. The cause of increased pressure is not fully understood.

Other Risk Factors

Other risk factors for osteonecrosis include radiation therapy, chemotherapy, and organ transplantation (particularly kidney transplantation). Osteonecrosis is also associated with a number of medical conditions, including cancer, lupus, blood disorders such as sickle cell disease, HIV infection, Gaucher's disease, Caisson disease, gout, vasculitis, osteoarthritis, and osteoporosis.

Who Is Likely to Develop Osteonecrosis?

Osteonecrosis affects both men and women. It can occur in people of any age, from children to the elderly. However, it is most common in people in their thirties, forties, and fifties.

What Are the Symptoms?

In the early stages of osteonecrosis, people may not have any symptoms. As the disease progresses, however, most experience joint pain. At first, the pain occurs only when putting weight on the affected joint. Later, it occurs even when resting. Pain usually develops gradually, and may be mild or severe. If osteonecrosis progresses and the bone and surrounding joint surface collapse, pain may develop or increase

dramatically. Pain may be severe enough to limit range of motion in the affected joint. In some cases, particularly those involving the hip, disabling osteoarthritis may develop. The period of time between the first symptoms and loss of joint function is different for each person, but it typically ranges from several months to more than a year.

How Is Osteonecrosis Diagnosed?

After performing a complete physical examination and asking about the patient's medical history, the doctor may use one or more bone imaging techniques to diagnose osteonecrosis. As with many other diseases, early diagnosis increases the chances of treatment success. The tests described below may be used to determine the amount of bone affected and how far the disease has progressed.

X Ray

A radiograph, or x ray, is probably the first test the doctor will recommend. A simple way to produce pictures of bones, an x ray is often useful in diagnosing the cause of joint pain. For osteonecrosis, however, x rays are not sensitive enough to detect bone changes in the early stages of the disease. So if the x ray is normal, the doctor may order more tests. In later stages of osteonecrosis, x rays may show bone damage, and once the diagnosis is made, they are often used to monitor disease progression.

Magnetic Resonance Imaging (MRI)

Research studies have shown that magnetic resonance imaging, or MRI, is the most sensitive method for diagnosing osteonecrosis in the early stages. Unlike x rays, bone scans, and CT (computed/computerized tomography) scans (see below), MRI detects chemical changes in the bone marrow. MRI provides the doctor with a picture of the affected area and the bone-rebuilding process. In addition, MRI may show diseased areas that are not yet causing any symptoms. Some doctors caution against aggressive treatment of osteonecrosis that has been detected by MRI but is not causing symptoms. One study has shown evidence that for a select group of patients in the early stages of osteonecrosis, the disease may improve spontaneously.

Computed/Computerized Tomography (CT scan)

A CT scan is an imaging technique that provides the doctor with a three-dimensional picture of the bone. It also shows “slices” of the bone, making the picture much clearer than x rays and bone scans. Some doctors disagree about the usefulness of this test to diagnose osteonecrosis. Although a diagnosis usually can be made without a CT scan, the technique may be useful in determining the extent of bone damage. CT scans are less sensitive than MRIs.

Bone Scan

A type of test called technetium-99m bone scanning is used most commonly in patients who have normal x rays and no risk factors for osteonecrosis. In this test, a harmless radioactive material is injected through an intravenous line, and a picture of the bone is taken with a special camera. The picture shows how the injected material travels through blood vessels in bone. A single bone scan finds all areas in the body that are affected, thus reducing the need to expose the patient to more radiation.

Biopsy

A biopsy is a surgical procedure in which a tissue sample from the affected bone is removed and studied. Although a biopsy is a conclusive way to diagnose osteonecrosis, it is rarely used because it requires surgery.

Functional Evaluation of Bone

Tests to measure the pressure inside a bone may be used when the doctor strongly suspects that a patient has osteonecrosis, despite normal results of x rays, bone scans, and MRIs. These tests are very sensitive for detecting increased pressure within the bone, but they require surgery.

What Treatments Are Available?

Appropriate treatment for osteonecrosis is necessary to keep joints from breaking down. Without treatment, most people with the disease will experience severe pain and limitation in movement within 2 years. To determine the most appropriate treatment, the doctor considers the following:

- the age of the patient
- the stage of the disease (early or late)
- the location and whether bone is affected over a small or large area
- the underlying cause of osteonecrosis. With an ongoing cause such as corticosteroid or alcohol use, treatment may not work unless use of the substance is stopped.

The goal in treating osteonecrosis is to improve the patient's use of the affected joint, stop further damage to the bone, and ensure bone and joint survival. To reach these goals, the doctor may use one or more of the following surgical or nonsurgical treatments.

Nonsurgical Treatments

Usually, doctors will begin with nonsurgical treatments, alone or in combination. Unfortunately, although these

treatments may relieve pain or help in the short term, for most people they don't bring lasting improvement.

- **Medications** – Nonsteroidal anti-inflammatory drugs (NSAIDs) are often prescribed to reduce pain. People with clotting disorders may be given blood thinners to reduce clots that block the blood supply to the bone. Cholesterol-lowering medications may be used to reduce fatty substances (lipids) that increase with corticosteroid treatment (a major risk factor for osteonecrosis). In one study, people who took cholesterol-lowering medications called statins along with corticosteroids significantly reduced the risk of developing osteonecrosis in the first place.
- **Reduced weightbearing** – If osteonecrosis is diagnosed early, the doctor may begin treatment by having the patient remove weight from the affected joint. The doctor may recommend limiting activities or using crutches. In some cases, reduced weightbearing can slow the damage caused by osteonecrosis and permit natural healing. When combined with pain medication, reduced weightbearing can be an effective way to avoid or delay surgery for some patients.
- **Range-of-motion exercises** – An exercise program involving the affected joints may help keep them mobile and increase their range of motion.

- **Electrical stimulation** – This treatment has been used in several centers to induce bone growth, and in some studies has been helpful when used prior to femoral head collapse.

Surgical Treatment

A number of different surgical procedures are used to treat osteonecrosis. Most people with osteonecrosis will eventually need surgery.

- **Core decompression** – This surgical procedure removes the inner cylinder of bone, which reduces pressure within the bone, increases blood flow to the bone, and allows more blood vessels to form. Core decompression works best in people who are in the earliest stages of osteonecrosis, often before the collapse of the joint. This procedure sometimes reduces pain and slows the progression of bone and joint destruction.
- **Osteotomy** – This treatment involves reshaping the bone to reduce stress on the affected area. Recovery can be a lengthy process, requiring 3 to 12 months of very limited activities. This procedure is most effective for patients with early-stage osteonecrosis and those with a small area of affected bone.
- **Bone graft** – This is the transplantation of healthy bone from another part of the body. It is often used to

support a joint after core decompression. In many cases, the surgeon will use what is called a vascular graft – which includes an artery and vein – to increase the blood supply to the affected area. Recovery from a bone graft can take from 6 to 12 months. The procedure is complex and its effectiveness is unproven. Clinical studies are underway to determine its effectiveness.

- **Arthroplasty/total joint replacement** – Total joint replacement is the treatment of choice in late-stage osteonecrosis and when the joint is destroyed. In this surgery, the diseased joint is replaced with artificial parts. Total joint replacement, or sometimes femoral head resurfacing, is often recommended for people for whom other efforts to preserve the joint have failed. Various types of replacements are available, and people should discuss specific needs with their doctor.

For most people with osteonecrosis, treatment is an ongoing process. Depending upon the stage of the disease, doctors may first recommend the least complex or nonoperative treatment plans, such as medication or reduced weightbearing. If these modalities are unsuccessful, surgical treatments may be needed. It is important that patients carefully follow instructions about activity limitations and work closely with their doctors to ensure that appropriate treatments are used.

What Research Is Being Done to Help People With Osteonecrosis?

With proper treatment, most people with osteonecrosis can lead productive lives. But there is still a lot to learn about prevention, diagnosis, and treatment. Some goals of current research are to:

- better understand how many people are affected by osteonecrosis by screening at-risk populations with MRI (magnetic resonance imaging)
- identify risk factors
- determine if genetic clotting disorders are risk factors for developing osteonecrosis in at-risk populations
- identify and/or develop new ways to diagnose osteonecrosis in its earliest stages, when nonsurgical treatment is most likely to help
- determine whether biological therapies, such as recombinant human bone morphogenic protein, are effective treatments for osteonecrosis
- develop new treatments and improve available treatments for osteonecrosis
- study key mechanical factors – such as the alignment of the hips, knees, and ankles – that influence treatment outcomes

- develop an animal model of osteonecrosis to study the disease
- improve hip replacement techniques and materials so that younger patients will not need more than one hip replacement in their lifetime
- better understand the body's reaction to steroids and why taking steroids increases a person's risk of developing osteonecrosis.

Where Can People Find More Information About Osteonecrosis?

- **National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS)**

National Institutes of Health

1 AMS Circle

Bethesda, MD 20892-3675

Phone: 301-495-4484 or

877-22-NIAMS (226-4267) (free of charge)

TTY: 301-565-2966

Fax: 301-718-6366

E-mail: NIAMSInfo@mail.nih.gov

www.niams.nih.gov

NIAMS provides information about various forms of arthritis and rheumatic disease and bone, muscle, joint, and skin diseases. It distributes patient and professional education materials and refers people to other sources of

information. Additional information and updates can also be found on the NIAMS Web site.

- **American Academy of Orthopaedic Surgeons**

P.O. Box 1998

Des Plaines, IL 60017

Phone: 800-824-BONE (2663) (free of charge)

www.aaos.org

The academy is the professional society of bone and joint surgeons. It seeks to further knowledge in the diagnosis and treatment of bone-related diseases. The academy publishes brochures on total joint replacement, arthritis, arthroscopy, and other subjects. Single copies of a brochure are available free of charge by sending a self-addressed, stamped (business-size) envelope to (name of brochure) at the address above.

- **National Osteonecrosis Foundation**

Good Samaritan Professional Building

Suite 201

5601 Loch Raven Blvd.

Baltimore, MD 21239

Phone: 410-532-5985

Fax: 410-532-5908

www.nonf.org

The foundation offers brochures, information on the disease, and a physician-finding tool on its Web site.

- **Arthritis Foundation**

P.O. Box 7669

Atlanta, GA 30357-0669

Phone: 404-872-7100 or 800-568-4045 (free of charge)

or call your local chapter (listed in the telephone directory)

www.arthritis.org

The Arthritis Foundation is the major voluntary organization devoted to supporting arthritis research and providing educational and other services to individuals with arthritis. It publishes free pamphlets and a magazine for members on all types of arthritis. It also provides up-to-date information on research and treatment, nutrition, alternative therapies, and self-management strategies for patients with certain autoimmune diseases. Chapters nationwide offer exercise programs, classes, support groups, physician referral services, and free literature. For more information, call your local chapter, listed in the white pages of the phone book, or contact the Arthritis Foundation at the above address.

- **The Hip Society**

951 Old County Road, #182

Belmont, CA 94002

Phone: 650-596-6190

Fax: 650-508-2040

www.hipsoc.org

This society maintains a list of physicians who are specialists in problems of the hip, and provides physician referrals by geographic area.

- **NIH Osteoporosis and Related Bone Diseases~National Resource Center**

2 AMS Circle

Bethesda, MD 20892-3676

Phone: 202-223-0344 or 800-624-BONE (free of charge)

TTY: 202-466-4315

Fax: 202-293-2356

E-mail: NIAMSBoneInfo@mail.nih.gov

www.osteo.org

The NIH Osteoporosis and Related Bone Diseases~National Resource Center provides patients, health professionals, and the public with an important link to resources and information on metabolic bone diseases. The mission of NIH ORBD~NRC is to expand awareness and enhance knowledge and understanding of the prevention, early detection, and treatment of these diseases as well as strategies for coping with them. The center provides information on osteoporosis, Paget's disease of bone, osteogenesis imperfecta, primary hyperparathyroidism, and other metabolic bone diseases and disorders.

Key Words

Arthroplasty – Another name for total joint replacement, a procedure in which a damaged joint is surgically removed and replaced with an artificial prosthesis. It is the treatment of choice for osteonecrosis when the joint is destroyed.

Arthritis – Literally means joint inflammation. It is a general term for more than 100 of the rheumatic diseases. Arthritis causes joint swelling, pain, and stiffness.

Aseptic necrosis – See osteonecrosis.

Autoimmune disease – A disease that results when the immune system mistakenly attacks the body's own tissues.

Avascular necrosis – See osteonecrosis.

Biopsy – A procedure in which tissue is removed from the body and studied under a microscope. A bone biopsy is a conclusive way to diagnose osteonecrosis.

Blood vessels – Arteries, veins, and capillaries that carry blood through the body.

Bone graft – The transplantation of healthy bone from one part of the body to replace injured or diseased bone in another part of the body.

Bone morphogenic protein – A protein extracted from the body and synthesized through genetic engineering. Research suggests it may be used to promote growth of bone damaged by osteonecrosis.

Bone scan – A type of test called technetium-99m bone scanning is used most commonly in patients who have normal x rays and no risk factors for osteonecrosis. In this test, a harmless radioactive material is injected through an intravenous line, and a picture of the bone is taken with a special camera. The picture shows how the injected material travels through blood vessels in bone. A single bone scan finds all areas in the body that are affected, thus reducing the need to expose the patient to more radiation.

Cancer – A term for diseases in which abnormal cells divide without control. Cancer cells can invade nearby tissues and can spread through the bloodstream and lymphatic system to other parts of the body.

Caisson disease – A syndrome that occurs when deep-sea divers, construction workers, or others working in a pressurized environment return to normal atmospheric pressure. Nitrogen in the bloodstream expands to form bubbles, causing pain and blocking circulation in the small blood vessels. The condition can potentially lead to osteonecrosis.

Cholesterol – Fat-like material present in the blood and most tissues. High levels of cholesterol can be a risk factor in the development of osteonecrosis as well as cardiovascular disease.

Computed (or computerized) tomography (CT) scan – An imaging technique that provides the doctor with a three-dimensional picture of the bone. It also shows “slices” of the bone, making the picture much clearer than x rays and bone scans.

Core decompression – A surgical procedure in which the inner layer of the bone is removed to reduce pressure within the bone, thereby increasing blood flow to the bone. In people with early osteonecrosis, the procedure may reduce pain and slow the progression of bone and joint destruction.

Corticosteroids – Powerful anti-inflammatory hormones made naturally in the body or man-made for use as medicine. Using corticosteroid medications is a risk factor for developing osteonecrosis.

Electrical stimulation – A procedure in which electromagnetic fields are set up around the bones or electricity is applied directly to the bones to induce bone growth. In some centers it has been helpful in treating patients with osteonecrosis prior to the collapse of the femoral head.

Epiphysis – The end of a bone where it meets another bone or bones to form a joint.

Femoral head – The round bony protrusion at the end of the thigh bone that fits into the acetabulum (socket) of the pelvis to form the hip joint. The femoral head often collapses in advanced osteonecrosis.

Femur – The upper leg, or thigh, bone. The end of the femur, where it meets the pelvis, is the most common site of osteonecrosis.

Gaucher’s disease – A congenital disease in which there is accumulation of fatty compounds in the liver, spleen, lymph nodes, and nervous system. Having the disease has been associated with the development of osteonecrosis.

Gout – A type of arthritis caused by the reaction of the body to needle-like crystals of uric acid that accumulate in joint spaces. This reaction causes joint inflammation, swelling, and pain in the affected joint, most commonly the big toe.

HIV (human immunodeficiency virus) – The virus that causes AIDS.

Immune system – A complex network of specialized cells and organs that work together to defend the body against attacks by “foreign” invaders such as bacteria and viruses. In some rheumatic conditions, it appears that the immune system does not function properly and may even work against the body.

Inflammation – A reaction of tissues to injury or disease, marked by four signs: swelling, redness, heat, and pain.

Ischemic necrosis – See osteonecrosis.

Lupus – Systemic lupus erythematosus (also known as lupus or SLE) is an autoimmune disease in which the immune system harms the body's own healthy cells and tissues. This can result in inflammation of and damage to the joints, skin, kidneys, heart, lungs, blood vessels, and brain.

Magnetic resonance imaging (MRI) – A procedure in which a strong magnet is used to pass a force through the body to create a clear, detailed image of a cross-section of the body. MRI detects chemical changes in the bone marrow and can show osteonecrosis in its earliest stages, often before it causes any symptoms.

Meniscus – A crescent-shaped wedge of cartilage in the knee joint. Tears of the meniscus have been associated with the development of both osteonecrosis and osteoarthritis in the knee.

Orthopaedist – A doctor who specializes in diseases of and traumatic injuries to the bones and musculoskeletal system. Also called orthopaedic surgeon.

Osteoarthritis – A disease in which the cartilage that cushions the ends of the bones breaks down, leading to joint pain and stiffness. The most common form of arthritis, osteoarthritis grows more common with age.

Osteonecrosis – A disease in which a temporary or permanent loss of the blood supply to the bones causes bone tissue to die and the bone to collapse. Also known as avascular necrosis, aseptic necrosis, and ischemic necrosis.

Osteoporosis – A disease in which the bone loses density and becomes so porous that it can break as a result of even minor trauma.

Osteotomy – A surgical procedure that involves reshaping the bone to reduce stress on a diseased or damaged area of a joint. It is often used for patients with advanced osteonecrosis and those with a large area of affected bone.

Range-of-motion exercises – A program of exercises involving joints affected by arthritis. These exercises may help keep the joint mobile and increase range of motion.

Sickle cell disease – A hereditary blood disease characterized by the production of an abnormal type of hemoglobin in the red blood cells. Having the disease increases one's risk of osteonecrosis.

Vasculitis – A disease in which there is inflammation of the blood vessels. Having vasculitis may increase one's risk of osteonecrosis.

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The mission of the National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), a part of the Department of Health and Human Services' National Institutes of Health (NIH), is to support research into the causes, treatment, and prevention of arthritis and musculoskeletal and skin diseases; the training of basic and clinical scientists to carry out this research; and the dissemination of information on research progress in these diseases. The National Institute of Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse is a public service sponsored by the NIAMS that provides health information and information sources. Additional information can be found on the NIAMS Web site at www.niams.nih.gov.



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