Nonunions

With modern treatment methods, most broken bones heal without any problems. After a fracture occurs, new bone tissue forms to connect the broken pieces. When the broken bone fails to heal it is called a "nonunion." A "delayed union" is when a fracture takes longer than usual to heal.

For bone healing to happen, the bone needs adequate stability and blood supply.

- **Stability**: To hold the bone together, a doctor may apply a cast, or you may need surgery, which can stabilize the bone using plates and screws or nails.

- **Blood supply**: Blood brings the components for healing to the fracture site. These include oxygen, healing cells, and the body's own chemicals necessary for healing (growth factors). The blood supply to the injured bone usually comes back on its own during the healing period.

A broken bone stabilized with a plate and screws.

Risk Factors/Prevention

Nonunions happen when the bone lacks adequate stability and/or blood flow. Factors that can increase the risk of nonunion include:

- Use of tobacco or nicotine in any form Smoking, chewing tobacco, and use of nicotine gum or patches significantly inhibit bone healing and increase the chance of a nonunion
- Older age
- Severe anemia
- Diabetes
- Medications including anti-inflammatory drugs such as aspirin, ibuprofen, and prednisone. The physician and patient should always discuss the risks and benefits of using these medications during fracture healing
- Infection

A broken tibia stabilized with a metal nail in the center canal and four horizontal screws.
A broken bone also needs adequate nutrition to heal. Protein, calcium, vitamin C, and vitamin D are absolutely necessary to heal broken bones. A careful diet is the best way to ensure adequate nutrition; dietary supplements that go beyond the daily requirements are not effective. The rare exception is the severely malnourished patient with many injured organs. The physician will discuss dietary guidelines and make recommendations for dietary supplements as needed.

Nonunions are more likely to happen if the injured bone has a limited blood supply. They are also more likely if the bone suffers severe trauma, even if it has an adequate blood supply.

- Some bones, such as toe bones, have inherent stability and excellent blood supply. They can be expected to heal with minimal treatment.
- Some bones, such as the upper thighbone (femoral head and neck) and small wrist bone (scaphoid), have a limited blood supply. The blood supply can be destroyed if these bones are broken.
- Some bones, such as the shin bone (tibia), have a moderate blood supply; but skin and muscle next to the bone can be destroyed by severe trauma. Injury can destroy the internal blood supply in the bone's marrow cavity. It can also destroy the external blood supply from the skin and muscle over the bone.

Some broken bones do not heal even when they get the right treatment -- surgical or nonsurgical.

**Symptoms**

Patients with nonunions usually feel pain at the site of the break long after the initial pain of the fracture disappears. This pain may last months, or even years. It may be constant, or it may occur only when the broken arm or leg is used.

**Diagnosis**

To diagnose a nonunion, the doctor uses imaging studies. Depending on which bone is involved, these may include X-rays (radiography), CT (computed tomography), and MRI (magnetic resonance imaging). Imaging studies let the doctor see the broken bone and follow the progress of its healing. A nonunion may be diagnosed if the doctor finds one or more of the following:

- Persistent pain at the fracture site
- A persistent gap with no bone spanning the fracture site
- No progress in bone healing when repeated imaging studies are compared over several months
- Inadequate healing in a time period that is usually enough for normal healing

Blood tests may also be used to investigate the nonunion's cause. These could show infection or another medical condition that may slow bone healing, such as anemia or diabetes.

**Treatment**

Nonsurgical and surgical treatments for nonunions have advantages and disadvantages. More than one alternative may be appropriate. Discuss with your doctor the unique benefits and risks of treating your nonunion. Your doctor will recommend the treatment option that is right for you.

**Nonsurgical Treatment**

Some nonunions can be treated nonsurgically. The most common nonsurgical treatment is a bone stimulator. This small device delivers ultrasonic or pulsed electromagnetic waves that stimulate healing. The patient places the stimulator on the skin over the nonunion from 20 minutes to several hours daily. This treatment must be used every day to be effective.
Surgical Treatment

Surgery is needed when nonsurgical methods fail. You may also need a second surgery if the first surgery failed. Surgical options include bone graft or bone graft substitute, internal fixation, and/or external fixation.

- **Bone Graft**
  - Bone grafts or bone graft substitutes can often "jump start" the healing process after normal healing has failed. A bone graft provides a lattice on which new bone may grow. Bone grafts also provide fresh bone cells and the naturally occurring chemicals the body needs for bone healing.

  A surgeon makes an incision and removes (harvests) pieces of bone from different areas on the patient. These are then transplanted to the nonunion site. The rim of the pelvis or "iliac crest" is most often used for harvesting bone. Although harvesting the bone is painful, the amount of bone removed does not cause functional, structural, or cosmetic problems.

- **Allograft or Cadaver Bone Graft** - An allograft avoids harvesting bone from the patient, and therefore, decreases the pain involved with treating the nonunion. Like a traditional bone graft, it provides scaffolding for the patient's bone to heal across the area of the nonunion. As time goes on, the patient's bone replaces the cadaver bone. Although there is a theoretical risk of infection, the cadaver bone graft is processed and sterilized to minimize this risk.

- **Bone Graft Substitutes and/or Osteobiologics** - Bone graft substitutes are commercially made products. As with allografts, bone graft substitutes avoid harvesting of the patient's own bone, which lessens the pain involved with treating a nonunion. Although bone graft substitutes do not have the fresh bone cells needed for normal healing, they provide a scaffold for the new bones to grow. To stimulate bone healing, the surgeon will supplement the bone graft substitute with other products which contain chemicals that the body needs to make bone.

Depending on the type of nonunion, any of the above materials, or a combination of materials, may be used to fix the nonunion.

Bone grafts (or bone graft substitutes) alone provide no stability to the fracture site. Unless the nonunion is inherently stable, you may also need more surgical procedures (internal or external fixation).
• **Internal Fixation** - Internal fixation stabilizes a nonunion. The surgeon attaches metal plates and screws to the outside of the bone or places a nail (rod) in the inside canal of the bone.

If a nonunion occurs after internal fixation surgery, another internal fixation surgery may be needed to increase stability. The surgeon may use a more rigid device, such as a larger rod (nail) or a longer plate. Removing a previously inserted nail and inserting a larger one (exchange nailing) increases stability and blood flow to a nonunion. An exchange nail is inserted at the end of the bone, which avoids making a large incision at the site of the nonunion. Internal fixation can be combined with bone grafting to help stability and stimulate healing.

• **External fixation** - External fixation stabilizes the injured bone. The surgeon attaches a scaffold-like rigid frame to the outside of the injured arm or leg. The frame is attached to the bone with wires or pins. External fixation may be used to increase the stability of the fracture site if instability helped cause the nonunion. External fixation can treat nonunions in a patient who also has bone loss and/or chronic infection.

**Research on the Horizon/What's New?**

To reduce the incidence of nonunions, scientists are developing stabilization techniques that minimize disruption of the blood supply to the bone.

Scientists are also investigating naturally occurring chemicals that the body needs for bone healing. These chemicals are known as growth factors. When a bone breaks, they are normally produced in the body in a certain sequence. One of these factors, BMP 7 (bone morphogenic protein 7), is currently available as a bone graft substitute. Researchers are concentrating on synthesizing these chemicals and determining the ideal way to bring them to the injured bone. Someday, physicians may be able to inject the chemicals directly into the nonunion to promote healing.

Last reviewed: September 2007

Co-developed by the Orthopaedic Trauma Association

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