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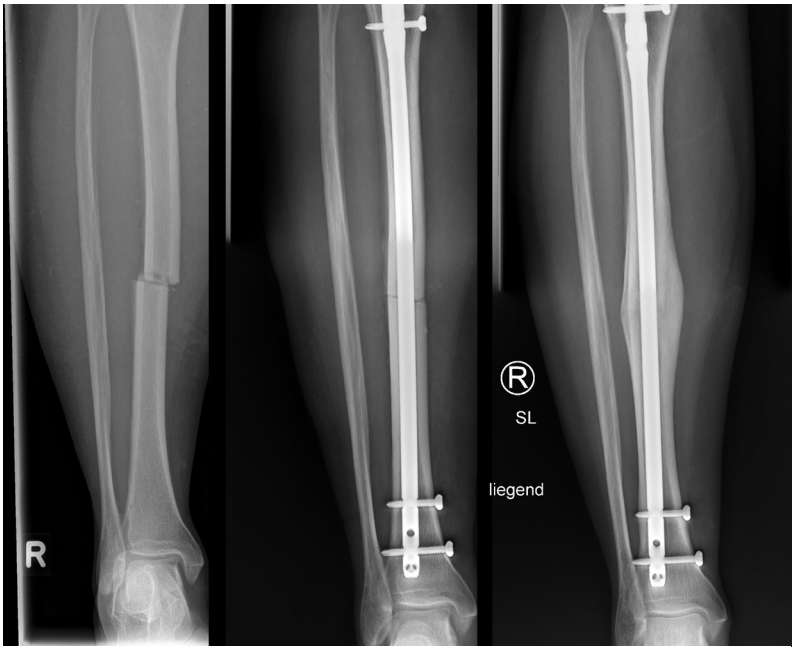
Science City Davos

How do broken bones heal?

Many of us have experienced it: We've been skiing, slipped on the ice, or played with the kids. We fell and fractured a bone. In many cases, a trip to the hospital and an X-ray follow to determine the extent of the damage. A cast is probably needed or surgery with surgical plates, nails and screws developed by the AO Research Institute Davos (ARI). After a few weeks of being patient, the bone has usually healed and life can resume its usual course. But how does it work?



The healing process of a broken lower leg: Left: First X-ray after the accident. Middle: X-ray image directly after surgery. Right: Healed bone with large callus formation. Image credit: AO Research Institute Davos

Signal initiates healing

The bone has the special ability to regenerate and regain almost the same shape and stability as before the injury. When a bone breaks, a danger signal is sent. It tells the body that there is an injury. This signal, in the form of inflammation, stimulates the repair response. While inflammation is important in the first few days of healing, it must be kept in check afterward so that new bone can form.

Bone heals in two different ways, directly or indirectly. After a fracture, stem and immune cells invade the fracture site. What happens next depends on how much the two ends of the bone move. If the damage is minor, such as in a crack, there is often no movement between the bony ends. This allows the new cells at the fracture site to convert directly into bone cells. This direct healing is rather rare, as there must be more immobilization of the fracture for this to occur. This can be achieved by surgery with screws.

Often, however, the two ends of a fracture are no longer in contact, which is why we speak of indirect healing. In this case, a plaster cast, a bone plate or a nail keeps the fractured ends close together. Under stress, small movements take place that cause the invading stem cells to become cartilage. This special cartilage forms a stabilizing thickening with new blood vessels as wound tissue (callus). Cartilage is normally found at the end of bones and covers the surface of joints,

where it allows painless movement. Cartilage, on the other hand, which is formed in bone fractures, has the ability to transform into bone.

Influence on healing

Health factors that reduce the formation of new blood vessels (e.g., diabetes, smoking) are known to slow or prevent the healing process. Also, if there is too much exercise, the fracture will not heal. Pseudoarthrosis can develop, often requiring another surgery to achieve better immobilization. However, it is not easy for patients to know when and how much weight-bearing should be done. For decades, ARI has been developing metal plates, nails, screws and the like that surgeons can use for more complicated fractures. These implants hold the bone in place and control the mechanical conditions in the fracture gap so that either direct or indirect healing is successful, depending on the nature of the injury.

What is the current research being done?

The goals of the research are to reduce inflammation, reduce the risk of infection and improve patient mobility. The ARI is currently conducting several studies to determine how mechanical loading regulates bone healing. The knowledge gained may help optimize rehabilitation and physical therapy. Furthermore, the ARI is looking for biomarkers for the healing response in the blood of patients. This is because, despite all the treatment options currently available, some patients still experience problems. Using the latest technologies, the ARI is able to detect sequences of nucleic acids that turn genes on and off and thus regulate healing. Researchers hope that by further understanding gene regulation during healing, they will be able to predict clues about an individual patient's healing response and develop new therapies.

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