Mahamutha Affshana.M et al /J. Pharm. Sci. & Res. Vol. 7(7), 2015, 441-442

ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in

Healing Mechanism in Bone Fracture.

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Abstract

Aim:The aim of this review is to determine the healing mechanism of bones.

Objective:To investigate healing mechanism and to evaluate the associated risk factors.

Background: Fracture is defined as a break or discontinuity in the periosteum of bone. Trauma or injury to the bones of the human body is increasing with the development of industry and transportation. Trauma is the biggest killer of human beings all over the world.

Fracture may be caused either by direct or indirect violence. Direct violence may be caused at the site of impact. Indirect violence causes the force to be transmitted to bone away from the site of impact and producing an impact there.Torsion produces simple or compound fracture.

Reduction of the fractured bone,immobilisation and provision of blood flow are important in the healing of fractures.

Reason:This review highlights the mechanisms of bone healing and the techniques used in the treatment.

INTRODUCTION

Bone formation

Bone formation is complex but the three-dimensional positioning of cells and matrices is straight forward. As in any discussion of bone formation it is important to keep in mind the distinction between bone as a tissue and bone as an organ.[1] Bone has a substantial capacity for repair and regeneration in response to injury or surgical treatment. Both processes involve a complex integration of cells, growth factors, and the extracellular matrix.[2]Bone defects are very challenging in the management of patients. They can result from a high-energy traumatic event, from large bone resection for different pathologies such as tumour or infection, or from the treatment of complex fractures [12]

Normal bone develops using only 2 mechanisms:

a) Intramembranous bone formation is mediated by the inner periosteal osteogenic layer with bone synthesized initially without the mediation of a cartilage phase.

b) Endochondral bone formation describes the synthesis of bone on a mineralized cartilage scaffold after epiphyseal and physeal cartilage have shaped and elongated the developing organ[1]

PHASES OF FRACTURE HEALING

There are three major phases of fracture healing ,[3]

1. Reactive Phase
   - Fracture and inflammatory phase
   - Granulation tissue formation
2. Reparative Phase
   - Cartilage Callus formation
   - Lamellar bone deposition
3. Remodeling Phase
   - Remodeling to original bone contour

Reactive

After fracture, the first change seen by light and electron microscopy is the presence of blood cells within the tissues adjacent to the injury site. Soon after fracture, the blood vessels constrict, stopping any further bleeding.[4] Within a few hours after fracture, the extravascular blood cells form a blood clot, known as a hematoma. All of the cells within the blood clot degenerate and die.[5] Some of the cells outside of the blood clot, but adjacent to the injury site, also degenerate and die.[6] Within this same area, the fibroblasts survive and replicate. They form a loose aggregate of cells, interspersed with small blood vessels, known as granulation tissue.[7]

Reparative

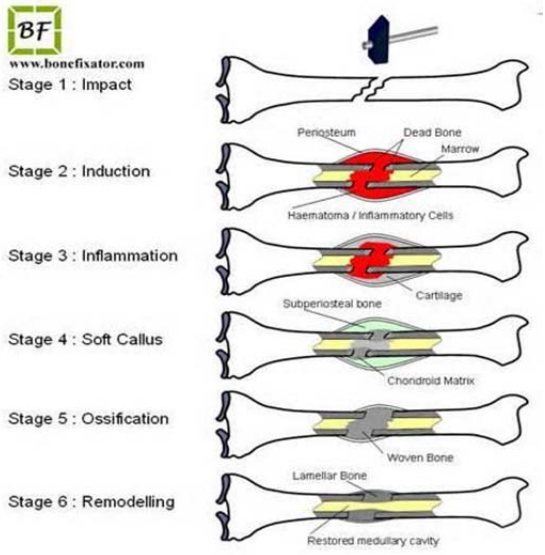
Days after fracture, the cells of the periosteum replicate and transform. The periosteal cells proximal (closest) to the fracture gap develop into chondroblasts which form hyaline cartilage. The periosteal cells distal to (further from) the fracture gap develop into osteoblasts which form woven bone. The fibroblasts within the granulation tissue develop into chondroblasts which also form hyaline cartilage.[8] These two new tissues grow in size until they unite with their counterparts from other parts of the fracture. These processes culminate in a new mass of heterogeneous tissue which is known as the fracture callus.[9] Eventually, the fracture gap is bridged by the hyaline cartilage and woven bone, restoring some of its original strength.

The next phase is the replacement of the hyaline cartilage and woven bone with lamellar bone. The replacement process is known as endochondral ossification with respect to the hyaline cartilage and bony substitution with respect to the woven bone. Substitution of the woven bone with lamellar bone precedes the substitution of the hyaline cartilage with lamellar bone. The lamellar bone begins forming soon after the collagen matrix of either tissue becomes mineralized. At this point, the mineralized matrix is penetrated by channels, each containing a microvessel and numerous osteoblasts. The osteoblasts form new lamellar bone upon the recently exposed surface of the mineralized matrix. This new lamellar bone is in the form of trabecular bone.[10] Eventually, all of the woven bone and cartilage of the original fracture callus is replaced by trabecular bone, restoring most of the bone's original strength.

Remodeling

The remodeling process substitutes the trabecular bone with compact bone. The trabecular bone is first resorbed by osteoclasts, creating a shallow resorption pit known as a "Howship's lacuna". Then osteoblasts deposit compact bone within the resorption pit. Eventually, the fracture callus is remodelled into a new shape which closely

duplicates the bone's original shape and strength. The remodeling phase takes 3 to 5 years depending on factors such as age or general condition.[7] This process can be enhanced by certain synthetic injectable biomaterials, such as cerament, which are osteoconductive and actively promote bone healing.[11]



BONE GRAFTS

The two types of bone grafts frequently used in spinal fusion are autografts and allografts. Autograft bone is transplanted from another part of the recipient body. Allograft bone is transplanted from genetically non identical members of same species. Both types of bone grafts are commonly used in spine surgery.Both types of bone grafts are commonly used in spine surgery. The ideal bone graft should be: 1) osteoinductive and conductive; 2) biomechanically stable; 3) disease free; and 4) contain minimal antigenic factors. These features are all present with autograft bone.[12,13]]

The advantage of allograft bone is that it avoids the morbidity associated with donor-site complications and is readily available in the desired configuration and quantity. The disadvantages of allograft include delayed vascular penetration,slow bone formation accelerated bone resorption, and delayed or incomplete graft incorporation.[14- 17] . In general,allograft bone has a higher incidence of nonunion or delayed union than autograft.[14,18-23]

The advantage ofAutograft provides bone cells (osteogenic cell) and growth factors that are essential for healing and bone regeneration.No risk of disease transfer. The Disadvantage is Need of second surgical procedure, Limited availability, Donor site pain ,Procurement morbidity ,Everyone is not having bone which is suitable for autograft**.**

CONCLUSION

An understanding of the basic science of bone healing is critical to the consistent success of spinal fusion surgery. Although great advances have been made in the field of spinal instrumentation, it is only a solid osseous union that will ensure long-term spinal stability. Selection of the most appropriate bone graft material as well as careful attention to the principles of bone healing can greatly facilitate the potential for clinical success.[24]If the bone is not healing as well as expected or fails to heal, the surgeon can choose from a variety of treatment options to enhance the growth of bone, such as continued immobilization for a longer period, bone stimulation, or surgery with bone grafting or use of bone growth proteins**.**

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