Biological response to implants fracture and their fixation

An Essay

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in Orthopaedic surgery.

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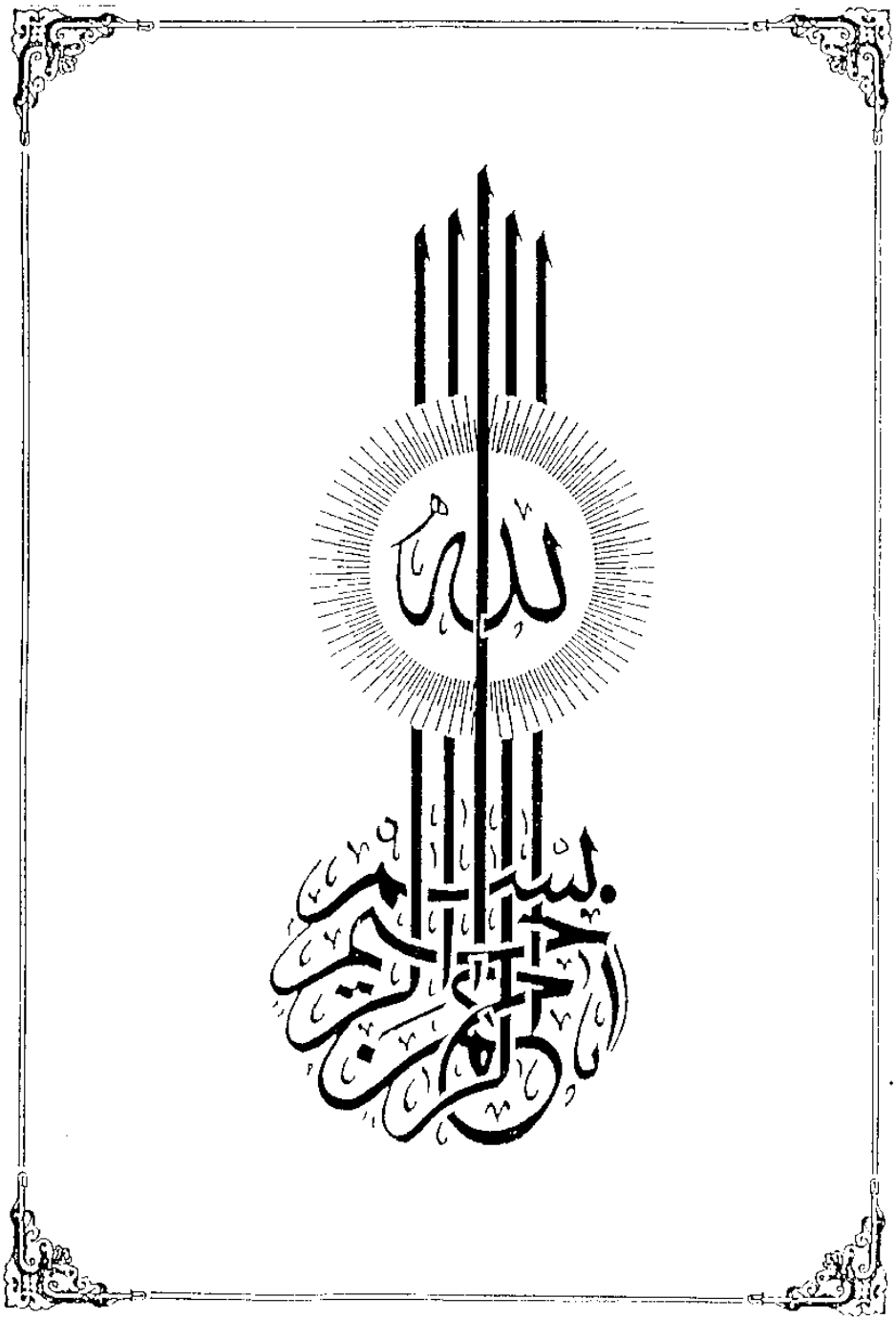

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قالوا سبحانك لا علم لنا إلا ما علمتنا

إنك أنت العليم الحكيم

صدق الله العظيم

سورة البقرة ٣٢

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Biological response to implants fracture and their fixation

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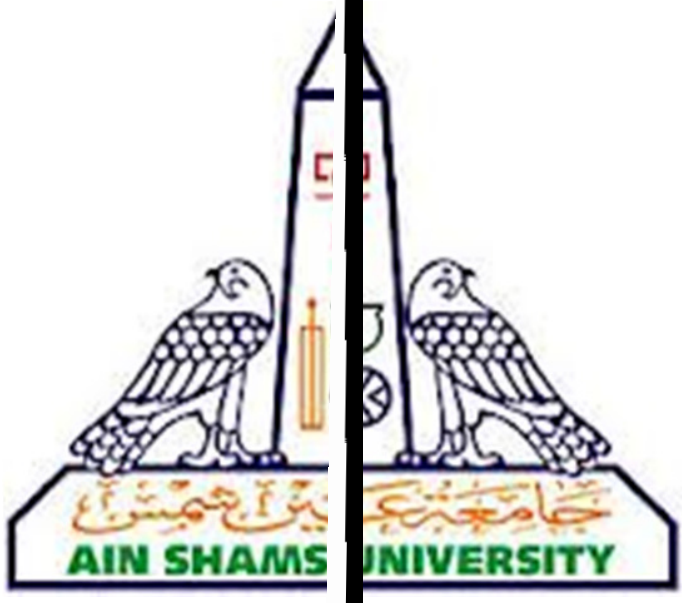
INTRODUCTION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Introduction

Fracture repair represent a local response designed to restore the capacity of bone to bear weight .

Physicians high expectation for skeletal restoration prompted vigorous research in the areas of bone grafting, graft substituation and analysis of local and systemic factors that regulate fracture healing. *(Charles N. Cornell et al 1992)*

The soft tissue and local blood supply are the most important factor for undisturbed fracture healing. *(Charles et al 1992)*

So, when preforming internal fixation, the delicate equilibrium between the advantage of stabilization and disadvantage of surgical intervension must be kept in mind, it is now considered better to trade some stability for preservation of an optimal biological reaction. *(Ganz,et al)*

Unreamed nail with interlocking, plates with limited contact as well as soft tissue preserving technique determine the current progress of internal fixation *(Melcher et al 1993)*

The incorporation of sythetically made implant into skeletal system constitutes bone injury and required bone repair. Mechanical integrity must be achieved between the implant and bone if the bone implant composite to be functional. *(Ostrum,et al 1994).*

In the short and middle range service (up to ten years postoperatively), it has proved easier to meet the mechanical requirment than the biological requirement imposed by local, systemic and remote site response to biomaterials, its constitiuents and their degradation products. *(Myron Spector 1990)*

Primary concerns are those that have become apparaent with extended longevity of joint replacement.

Wear of bearing surfaces and loss of bone stock is a result of osteolytic response to particulate wear debris and to stress shielding effect in addition to the long term biological and clinical sequelae of metal ion release, particuly in uncemented devices in young individual remain unknown. *(Myron Spector 1990)*

Natural Bone healing

Natural bone healing refers to the process that has been selected through evolution to repair large bone defects and fractures. The process is actually a regeneration of the injured bone. In the ideal situation when the reparative process is completed, no scar is present, only remodeled osseous tissue.

Fracture healing (i.e bone regeneration) compromises three major event. The first event in the regenerative process is the recruitment of osteoprogenitor cells to the site of the fracture.Osteoprogenitor cells are differentiated or inducible preosteoblasts that , when appropriately stimulated (either through induction or modulation) will become active bone-producing cells, some of these cells, such as osteocytes, periosteal cells, endosteal cells are capable of forming bone, but they are not actively engaged in osteosynthesis at the time of fracture. Primitive fibroblast from adjacent soft tissues also may be recruited to the callus.

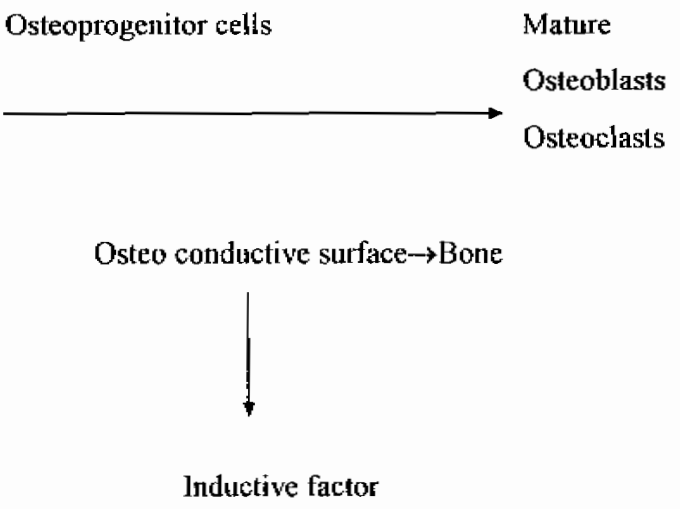
Modulation,

The second major event in the repair process is the method by which a cell is stimulated to activate a distinct physiologic process. Its function is to activate periosteal cell and osteocytes for repair process. The multipotential stem cells and prefibroblasts must

differentiate to give rise to osteoblasts by the process of induction because the fracture gap originally contains no chondrocytes or osteocytes. Their presence in the healing stages can only be the result of induction factors or substances that bring about this induction one the inductors and the process in the osteoinduction. Biochemical , mechanical and biophysical factors have been identified as having a significant role. Specific osteoinductors identified as having a significant role.

The final major event of the repair process. Osteoconduction , relates to the establishment of an appropriate environmental template on which activated osteoprogenitor cells can produce bone. Osteoprogenitor also facilitates bone production and deposition in the appropriate three-dimensional array and enhances the ability of the regeneration process to bridge large segmental defect. Collagen hydroxy apatite are the prototype osteoconductor substance.

To summarize, bone regeneration requires an osteoconductive surface modulated or induced osteoproducing cells to create a competent bone mass. *(Cornell and Lane 1992).*



Fracture healing requires an osteoconductive surface activated osteoprogenitor cells and osteoinductive factor to regenerate a remodelled bone mass.

At the moment of impact, the energy absorbed by the bone leads to mechanical and structural failure. Beside the actual break in continuity of bone, there is a disruption of the blood supply at the fracture site. The biology of fracture repair is actually a tissue reparative process rather than a healing process.

This regenerative process may be described as consisting of four stages.

Stage 1 inflammation:

Inflammation begins immediately after a fracture is sustained and consists initially of the appearance of hematoma and fibrin clot along with platelets, PNL, monocytes or macrophages at the fracture site. In addition hemorrhage and cell death are seen where blood vessels are disrupted. Bone necrosis at the ends of the fracture fragments with cellular release of lysosomal enzymes and other by- products of the cell death. Fibroblasts, Mesenchymal cells and osteoprogenitor cells appear shortly thereafter.

The mesenchymal and osteoprogenitor cells may arise from transformed endothelial in medullary canal and / or from the periosteum and /or by osteogenic induction of cells within the surrounding muscle and soft tissue. The blood vessels of periosteal callus are entirely new and originate from the surrounding extra skeletal tissues and from medullary canal. A tissue oxygen gradient is necessary for maintenance of angiogenesis in these healing tissues, Angiogenesis may be controlled by macrophages, which produce angiogenic factor under hypoxic condition.

Stage 2 soft callus:

Begin when pain and swelling subside and lasting until the body fragments are united by fibrous or cartilaginous tissue and are no longer freely moveable.