Biologically Active Implantable Engineered Solutions







Early Massive Endoprosthetic Replacement

Seddon & Scales 1948

Incorporation of plates in animal model

Joint Sparing Surgery

Where remaining bone after tumour resection would not accept an intramedullary stem.

Extracortical Plate Fixation

CT to measure erosion then specific implants

Bone Organisation

Structure of Bone

Compact Bone & Spongy (Cancellous Bone)

Type II collagen 90-95% of total collagen content in articular cartilage

Collagen

Provides framework

Gives tensile strength

amino

tropoco ~300 nr

fibrils ~1 µm

> Triple helix consists of two $\alpha 1$ and one $\alpha 2$ chains quarter staggered to produce a collagen fibril

May constitute majority of length of molecule

Collagen

Hole zones (gaps) exist within collagen fibril between the ends of molecules

Pores exist between sides of parallel molecules

Collagen

Mineral deposition (calcification) occurs within these hole zones and pores

Cross linking decreases solubility and increases tensile strength of collagen

Age Related Bone Morphological Changes

 24
 63
 89

Vertebral Fractures

Quick setting bone cement injected into fractured vertebra

Implant Stability

Prognosis dependent on biomechanical stability of fracture implant construct

Bones are Dynamic and Heal

Fracture Repair

Continuum of processes

Inflammation first

Repair (soft callus)

Maturation to woven bone callus)

Ending in remodelling

Fracture Healing Phases Inflammation (hours-days) Clot brings in haemopoetic cells with osteoprogenitor cells

Growth factors

Granulation tissue forms

Fracture Healing Repair Phase (Mnths)

Primary callus response within 2 weeks

When bone ends not in contact bridging soft callus forms and replaced by woven bone

Medullary callus forms later and more slowly

Fracture Healing Remodelling Phase (Years)

Woven bone replaced by lamellar bone

Healing complete when there is repopulation of marrow space

Bone Remodelling

Responds to piezoelectric charges

Compression is electronegative stimulates osteoblasts and bone formation

Tension is electropositive stimulating osteoclasts and bone resorption

Modulating Bone Remodelling

Fibrous layer of periosteum Osteogenic layer of periosteum Thirth Outer circumferential lamellae Lacunae containing osteocytes Canaliculi Cementing line Compact bone 111111111111111111111111 Interstitial lamellae Haversian system nner circumferential lamellae Blood vessel and endosteal lining of Volkmann's canals haversian canal Blood vessels into marrow Endosteum

Affected by mechanical stimulation (Wolff's Law)

No external stress leads to bone loss

Fracture Stabilisation

Traction, cast, external fixation, internal fixation prevents repeated disruption of repair tissue

Sometimes a combination of both

Graft and Bone Transport

- Containing cells
- Vascularised

Electrical Fields and Pulsed Ultrasound

Alter cell proliferation and promote bone formation

Stimulate delayed and non unions

Demineralised Bone Matrix

Articular Cartilage

Surface of cartilage

Pathogenesis Osteoarthritis

Loss of proteoglycan reduces cartilage hydration

Cartilage then less able to withstand compressive load

Leads to fibrillation

Pathogenesis

Under compressive loads some chondrocytes release lysosomal enzymes

Breakdown proteoglycan matrix

Load and

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Developments in Materials

Developments in Knowledge

The MHC Locus

Biological Therapy Available

Cells and Structures

Growth

Reserve zone (matrix production/storage)

Proliferative zone (matrix production/cellular proliferation)

Zone of maturation

Zone of degeneration

Zone of provisional calcification

Hypertrophic zone (Preparation of matrix for and initiation of calcification)

Biologically Active Implantable Engineered Solutions

- Will help us restore structures
- Incorporate and restore function
- Any musculoskeletal tissue
- Wear, Trauma, Cancer Functions

