

Growth and healing of bones

Bone Origin

- All bone derives from mesenchyme which is loosely organized embryonic connective tissue derived from the embryonic mesoderm.
 - Different parts of the skeleton have different embryological origin:
1. The vertebrae and the ribs are formed by the sclerotome which is part of the somites. The somites are formed after segmentation of the paraxial mesoderm.
 2. The cranium develops from the mesenchyme which is present around the developing brain.
 3. Limb bones are thought to be derived from lateral mesodermal cells.

Bone Formation

There are two main ways that bones are formed in the human body:

- Intramembranous ossification mostly occurring in flat bones and bones of the skull. These bones are formed directly from mesenchyme.
- Endochondral ossification which takes place in long bones of the skeleton. These bones are formed by cartilage derived from mesenchyme.

Intramembranous ossification

Most flat bones are being formed this way. Mesenchyme model of bone is formed during embryonic period and direct ossification begins in the fetal period (8 months after fertilization). This process begins when groups of mesenchyme cells differentiate into osteoblasts. Osteoblasts produce osteoid and then calcification occurs. As calcification progresses some osteoblasts get trapped and become osteocytes. By this way woven bone is being produced with cavities for bone marrow. Then following remodeling the woven bone is changed into lamellar bone. This leads to cancellous bone in between two lamellar bone layers.

Endochondral Ossification

This type of bone formation takes place in pre-existing hyaline cartilage model which resembles the future bone and forms most bones of the skeleton. Bone models are formed during the fetal period. Firstly mesenchymal cells condense and differentiate into chondroblast which form the bone model. In the middle of the bone model the cartilage calcifies (calcium salts invade) and capillaries from the periosteum (fibrous sheath around the model) grow into the calcified cartilage and supply its interior (primary ossification centre). The cartilage in the epiphyses continues to grow (appositional growth) which leads to growth of the bone in length. After birth, secondary ossification centres form in the epiphyses. Ossification in the epiphyses is similar to that in the diaphysis except that the spongy bone is retained instead of being broken down to form a medullary cavity. Cartilage remains between the epiphysis and diaphysis. This is called the epiphyseal plate which calcifies later by fusion of two sites and is seen as a line.

Bone Growth at Epiphyseal Plate

The epiphyseal cartilage is responsible for the growth in length of the bone and disappears in adults at roughly 21 years of age. Epiphyseal plates are divided into 5 zones:

1. Resting zone where we only have hyaline cartilage
2. Proliferation zone where chondrocytes begin to divide rapidly
3. Hypertrophic Cartilage zone where chondrocytes have accumulated collagen in their cytoplasm
4. Calcified cartilage zone where chondrocytes die by apoptosis and calcification occurs.
5. Ossification zone where bone tissue first appears. Capillaries and osteoprogenitor cells invade.

Types of Fracture -classification

Fractures classified by cause:

- Traumatic (Fall)
- Pathological (Osteoporosis)

Fractures classified by type:

- Complete (bone fragments separate completely)
- Incomplete (bone fragments are still partially joined)
- Linear (parallel to the bone's axis)
- Transverse (right angle to the bone's axis)

- Oblique(diagonal to a bone's axis)
- Spiral(one part of the bone is twisted)
- Comminuted(bone is broken into a number of pieces)
- Impacted(bone fragments are driven into each other)

Healing of Bones

- Healing begins on the time of the fracture
- For a fracture to heal properly ends must be brought together to normal position.
- Surrounding fibroblasts proliferate + secrete collagen
- Collagen forms a collar of callus to hold bones together
- Bone remodelling occurs in fractured area and callus calcifies
- Callus is resorbed and replaced by bone

MESCHER, Anthony L. *Janqueira's Basic Histology*. 12th edition edition. 2010. ISBN 978-0-07-163020-7.

MOORE, Keith L. *Before We Are Born*. 7th edition. 2007. ISBN 978-1-41-603705-7.