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Review Article

Enthesis: A Brief Review

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ABSTRACT

Bone is a living tissue capable of changing its structure as the result of the stress to which it is subjected. It consists of cells, fibers and matrix. Calcification of extra cellular matrix makes it hard. The slight degree of elasticity in the bone is due to the presence of the organic fibers. The main function of the bone is protection of some of the vital organs like brain, spinal cord, heart and lungs. It also acts as a lever which helps in locomotion and movement. It is the main storage house of the calcium salts. The cavity of the bone consists of delicate blood forming bone marrow.[1] The two forms of bones are compact and cancellous bone. Compact bone exists as a solid mass however the cancellous bone has a branching network of trabeculae. The arrangement of trabeculae is such that it resists the stress and strain to which the bone is exposed. Entheses is an interface where the tendon meets bone. These are the sites of stress concentration at the hard and soft tissue function where mechanical properties differ. They play a pivotal role in the diagnosis of various types of arthritis. However, not much importance has been given by the anatomists and the clinicians towards the study on entheses. This article aims to provide a brief account on entheses to draw the attention towards the known but ignored entity called entheses.

1. Introduction

Vertebrate skeleton is an adaptive tissue serving several fundamental mechanical metabolic functions throughout life. The primary role of skeleton is to provide a scaffold for the soft tissue while protecting the vital areas of the body that are necessary for one's survival. Apart from this, the skeleton also maintains its tissue integrity. Hence, the tissue is capable of sustaining the mechanical loads throughout the life of an individual. Skeletal tissue is anisotropic and hence changes its macro and micro structured properties in relation to the direction and concentration of various mechanical stimuli. Bone

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metabolism and adaptation occurs throughout life in humans and other mammals in 4 distinct envelopes:

1) Periosteal – outer cortical
2) Intracortical
3) Endosteal
4) Trabecular

Each of these surfaces varies in their response to the local systemic influences as well as their tissue volume to surface area ratio.[2] The main effector cells are however similar in all the four envelopes and hence the bone formation and resorption along these surfaces has the same physiological mechanisms. The two main effector cells of the skeletal tissue that maintains the functional integrity of the bone are osteoblasts and osteoclasts.

1.1. *Osteoblasts*

Cells forming new bone by synthesizing and secreting unmineralized bone matrix are termed as osteoblasts. These osteoblasts are the specialized fibroblasts and are related by lineage to osteocytes and bone lining cells.

1.2. *Osteoclasts*

These are the multi nucleated cells. Originate from the union of mononuclear phagocytes in the hematopoietic red marrow found within the trabecular envelope.[3] These cells digest the bones collagenous matrix and are similar to the macrophages present in all the tissues.

Both of these cell types are responsible for physiological modeling and remodeling responses wherein the skeletal tissue is spatially distributed and renewed to adapt to its altering systemic and local mechanical environment.

1.3. *Entheses*

An interface where the tendon meets bone is called entheses (Fig. 1). These are the sites of stress concentration at the hard and soft tissue function where mechanical properties differ.[4] They not only provide fare transmission but also anchor tendons thereby enabling the static and dynamic load resistance. To achieve this tendon fibers splay, forming a plexus at the insertion point that provides a firm anchor, equally resistive to insertion angle change in response to variable directional loads occurring during joint movement.[5] Often, the entheses intermingles with one another (eg. Insertion of vastus lateralis, vastus intermedius, adductor magnus and adductor brevis muscles along the lateral tip of linea aspera) overlapping attachment sites for greater tendon security.[4]

Additionally, Knese and Biermann (1958)[6] have proposed that the splaying of entheses is not only vital for anchorage but also in limiting the degree to which a tendon stretches. As tendons stretch they narrow increasing their vulnerability to rupture.

Entheses has two categorical units:

Fibrous and fibrocartilagenous: depending on the tissue type present at the osteotendinous junction.

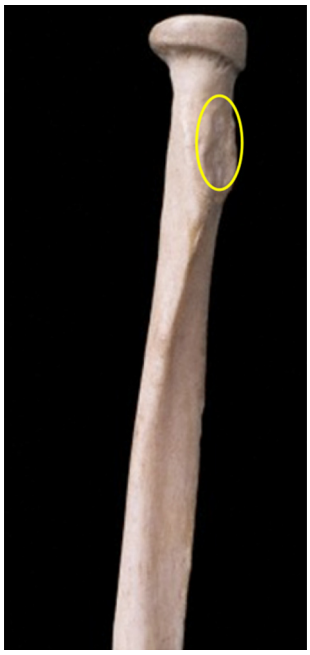

Fig. 1 – Depicts the site of entheses on radius.

Fibrocartilagenous entheses are only present on the epiphyseal or apophyseal long bone ends, whereas fibrous entheses attach to long bone diaphyses (Fig. 2). This distinction between entheses type and location corresponds to the bone origin, either intramembranous or endochondral ossification.

Entheses (Fig. 3) rooted in the thick layer of cortical bone are fibrous ossifying intra membranously while those attaching to the thick cortical layers are fibrocartilagenous ossifying endochondrally. Benjamin et al (2002),[7] suggests this may relate to nutrient foramen access. However, the understanding of early postnatal enthesial development is limited.

Herrov in 1986,[5] described the periosteal surface of diaphyseal entheses in fetal rabbit long bones to be coarse fibered compositely falling between fibrocartilage & lamellar bone.

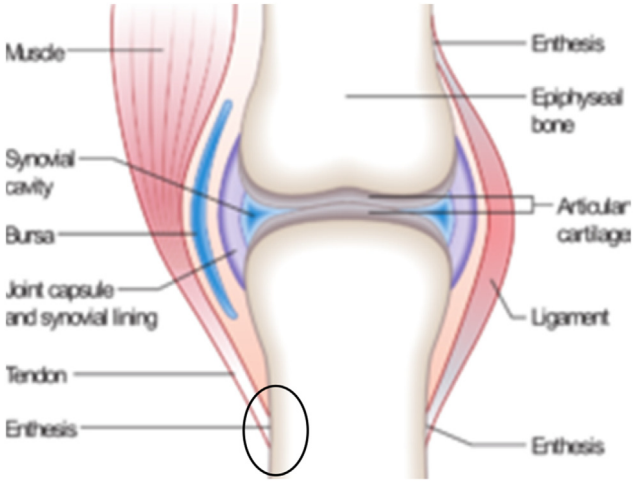

Fig. 2 – Diagrammatic representation of entheses.