# Orthodontics

## Orthodontic Tooth Movement

### Tooth Movement

The term tooth movements based on the principle that if prolong pressure is applied to the tooth, tooth movement will occur as the bone around tooth remodels that it mean bone is selectively removed is some areas and added in others; so when force is applied to the crown of tooth it is transmitted through the root of the tooth to the periodontal ligament (PDL) and alveolar bone and will lead to tooth movement.

Tooth movement in orthodontics is based on the application of biologic forces to the teeth that lead to creation of pressure and tension sites, resulting in bone removal in certain area (pressure site) and bone formation at other (tension site). This will lead to sockets migration, i-e tooth movement. The PDL in addition to its cushioning action against sudden blows and its role in eruption and mediating sensory response is also vital in the process of orthodontic tooth movement.

**Notes:**

- Normal PDL: is a heavy collagenous supporting structure attached to the cementum of the root of each tooth from one side and to its surrounding alveolar bone lamina dura and usually PDL occupy 0.5 mm space in width around all parts of the root and it composed of collagen fibers, cellular elements, tissues fluids, blood vessels and &nerve endings.
- Force applied to teeth can also affect the pattern of bone apposition and resorption at site distant from teeth particularly the sutures and bony surface of maxilla and bony surface on both sides of TMJ.

## Theories of Orthodontic Tooth Movement:

### 1. The piezoelectric (bio-electric) theory:

It relates tooth movement at least in part to changes in bone metabolism controlled by electric signals that are produced when alveolar bone is subjected to force.

Piezoelectricity in bone is an electric charge produced by the deformation of crystalline structures like hydroxyapatite, collagen, and fibrous protein.

So, in this theory, the electric signals are the stimulus for cellular differentiation and ultimately tooth movement.

**2. The pressure-Tension Theory:**

The most commonly and classic accepted theory it relies a chemicals rather than electrical signal as stimulus for cellular differentiation and ultimately tooth movement.

In this theory, an alteration in blood flow within the PDL is produced by sustained pressure that causes the tooth shift position within PDL space, compressing the ligament in some areas while stretching it in others.

Therefor the blood flow is decreased where the PDL is compressed, while the blood flow is usually maintained or increased where the PDL is under tension.

Alteration in blood flow quickly creates changes in the chemical environment.

These chemical changes acting either directly or by stimulating the release of other biologically active agents which called (chemical messengers) then stimulation of cellular differentiation and activity will occurs especially formation of osteoblasts and osteoclasts cells".

This will initiate cell differentiation after at least 6 hours per day, then after 2 days favorable frontal bone resorption start that lead to tooth movement.

Therefore this theory shows three stages:

1. Alteration of blood flow associated with pressure change with in the PDL.

2. The formation and/or release of chemical messengers.

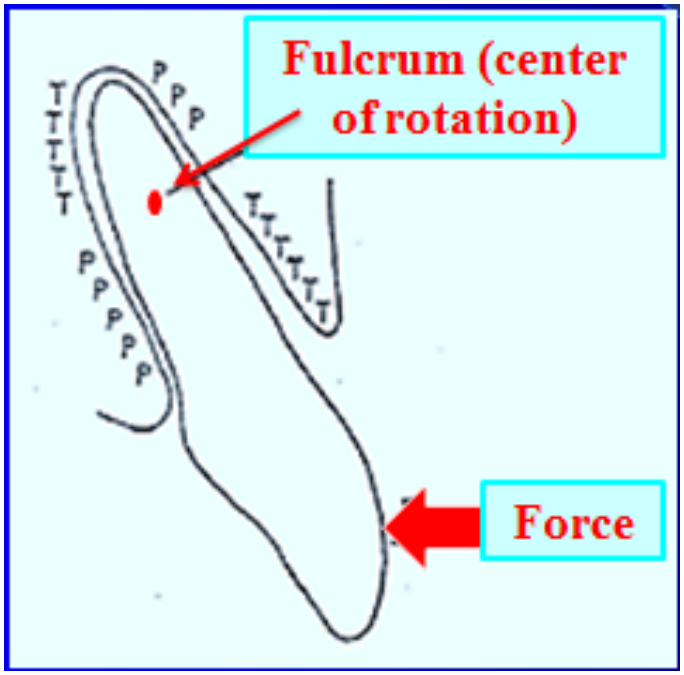
3. Differentiation and activation of cells which are responsible for bone remodeling.

If a palatally directed force is applied to the labial surface of a maxillary central incisor [as shown in figure -1-], the tooth will tilt around a fulcrum located approximately at the junction of the apical one-third and the coronal two-thirds of the root. As a result, pressure [compression] sites will be created at the coronal one-third of the socket wall in the direction of the force and at the root apex in the opposite direction, while tension sites will occur opposite to the pressure sites (Fig. 1). If this applied force was OPTIMAL, then PARTIAL occlusion of the blood vessels and cell proliferation occur within the PDL at pressure sites. Direct (frontal) resorption of the bone of the socket wall adjacent to

the pressure sites takes place within a few days by the osteoclastic activity.

At tension sites, the periodontal fibers are stretched and proliferation of fibroblasts and osteoblasts is followed an increase in the length of the periodontal fibers which are subsequently remodeled. Osteoid is deposited on the bony socket wall at the tension sites and is then calcified to form woven bone, which in turn is remodeled into mature bone. Thus the tooth moved through the alveolar bone under the influence of an optimal [not exceeding capillary pressure] force.

If the applied force was excessive (heavy), then direct resorption of bone does not occur due to the COMPLETE occlusion of the blood vessels within the PDL which results in a sterile necrosis [called hyalinization because of its structureless microscopic appearance] and initially a cessation of tooth movement. After a delay of 2-3 weeks, indirect resorption takes place outwards from the marrow spaces of the adjacent alveolar bone and then the tooth moves. This is called Undermining Resorption.



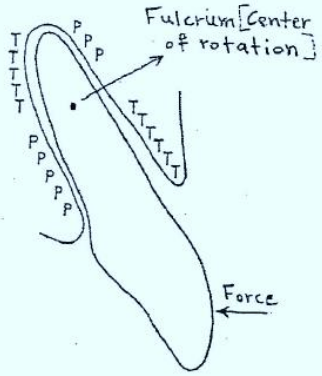




Figure (1)

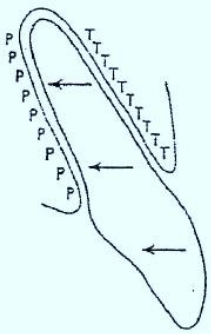


Figure (2)