

Orthodontic

Biological Principle Of Orthodontic Tooth Movements

In orthodontics, tooth moves through bone and brings the periodontal ligament with it.

The Periodontal Ligament

Normal width 0.5 mm or 500 micrometers.

Component of PDL

- Collagenous fibers.
- Cellular elements
- Fibroblasts which forms collagen fiber
- Fibroclasts which destroy collagen fiber
- Osteoblasts which forms bone
- Osteoclast which destroy the bone(remodeling)
- Cementoblasts which form cementum
- Cementoclasts which destroy cementum
- Vascular and neural elements (unmyelinated free endings associated with perception of pain and receptors associated with pressure and position information (proprioception)).
- Tissue fluids derived from the vascular system.

Alveolar Bone

Thin cortical bone and porous (lamina dura)

Trabecular bone underneath

Bone must remodel before teeth can be moved

Tooth cannot move unless bone apposition and resorption take place. There will be no tooth movement unless there is a force.

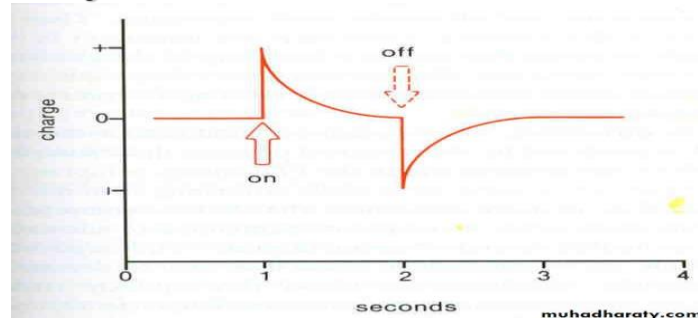
Mechanisms of Tooth Movement (theories)

Piezoelectric theory.

Pressure-tension theory.

Piezoelectric theory.

This theory explained tooth movement as force applied to the tooth structure will cause deformation of crystals structure produce flow of electric current as electron displaced from one part of the crystal to another and produce change in metabolism of the bone initiate tooth movement



It is classical theory of tooth movement based on chemicals signals that stimulate cellular differentiation and ultimately tooth movement

Pressure-tension theory

Change in blood flow as force applied to the tooth (decrease in pressure side and maintained or increase in tension side)

change in blood flow change chemical environment

O₂ level decrease in compressed area and increase in tension side

This will directly or indirectly by stimulating other biological active agent (AMP adenosine monophosphate) will stimulate cell differentiation

Effects of LIGHT forces on the periodontium

Light, continuous forces

Osteoclasts formed

Removing lamina dura

Tooth movement begins soon after force deliver

This process is called “FRONTAL RESORPTION”. “Frontal resorption” because it occurs between the root and the lamina dura.

Effects of HEAVY forces on the periodontium

Heavy, continuous forces

Blood supply to PDL occluded

Aseptic necrosis

PDL becomes “hyalinized” – “HYALINIZATION”

This process is called “UNDERMINING RESORPTION”.

Tooth movement occurs between 7-14 days

“Undermining resorption” because it occurs on the underside of lamina dura, not between lamina dura and the root.

Frontal resorption occurs in the PDL, whereas undermining resorption occurs underneath the lamina dura.

Frontal resorption facilitates orthodontic tooth movement, whereas undermining resorption impedes orthodontic tooth movement.

Experience has shown that orthodontic appliances should not be reactivated more frequently than at 3-week intervals. A 4- to 6-week appointment cycle is more typical in clinical practice. Undermining resorption requires 7 to 14 days (longer on the initial application of force, shorter thereafter).

When this is the mode of tooth movement and when force levels decline rapidly, tooth movement is essentially complete in this length of time.

Mechanical principle Of Orthodontic Tooth Movements

Force:

a load applied to an object that will tend to move it to a different position in space.

Orthodontic Force:

force applied to teeth for the purpose of effecting tooth movement, generally having a magnitude lower than an orthopedic force.

Intensity of Force:

according to the intensity of force , Orthodontic Force is divided into 3 categories:

Light : (60-120 gm), (2-4 ounce) . (Ounce x 28 , 3495 = gm)

Medium : (120-180 gm), (4-6 ounce)

Heavy : (over 180gm), (over 6 ounce)

Duration of Force:

according to the intensity of force , Orthodontic Force is divided into 3 categories:

Continuous: a force that is maintain between certain intervals (does not drop to zero between patient visits)

interrupted : force level decline steadily to zero between activations. Like: various types of elastics.

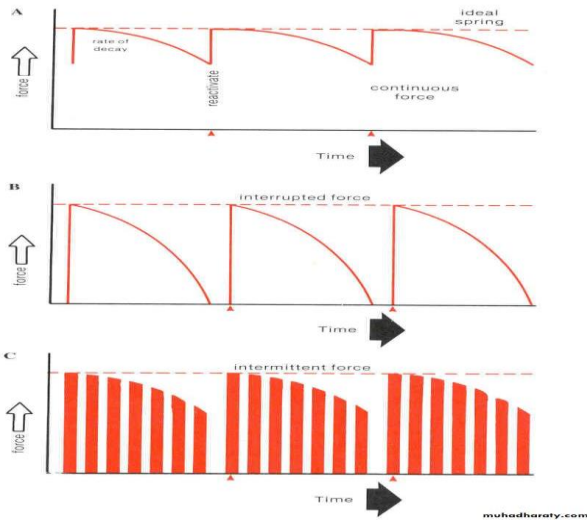
intermittent : force level decline to zero intermittently when the orthodontic appliance removed from patient mouth.

Characteristics of Clinical Force:

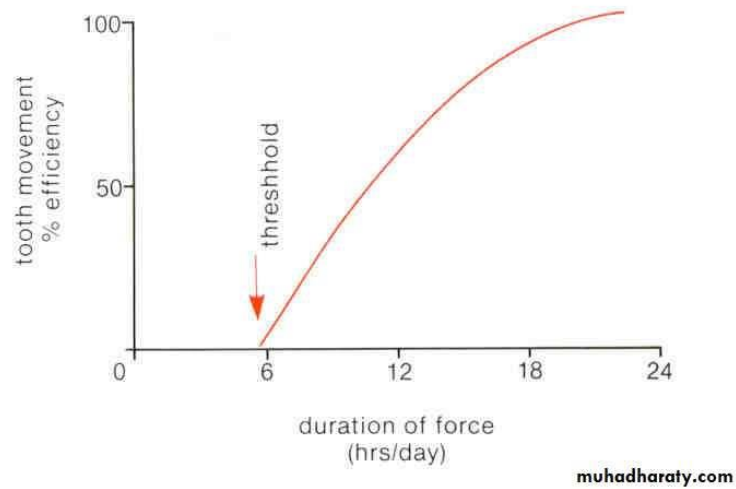
Light Continuous for Orthodontic tooth movement.

Heavy intermittent for Orthopedic skeletal effect. i.e.

(Growth modification either for increasing or decreasing, or to change direction or to stop the growth of certain skeletal bones).



Force Duration



Threshold --- 6 hrs per day.

No tooth movement if forces are applied less than 6 hrs/d.

From 6 to 24 hrs/d, the longer the force is applied, the more the teeth will move.

Force Magnitude (Level)

In the range of 10 to 200 grams.

Varies with the type of tooth movement.

Light, continuous forces are currently considered to be most effective in inducing tooth movement.

Heavy forces cause damages and fail to move the teeth.

Type of movement	Force* (gm)
Tipping	35-60
Bodily movement (translation)	70-120
Root uprighting	50-100
Rotation	35-60
Extrusion	35-60
Intrusion	10-20

*Values depend in part on the size of the tooth; smaller values appropriate for incisors, higher values for multirrooted posterior teeth.

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Response to normal function

During mastication heavy intermittent forces are applied 1 or 2 up to 50 Kg

Quick displacement of the tooth within the PDL space is prevented by incompressible tissue fluids and very little fluid is squeeze out

If pressure against a tooth is maintained, however, the fluid is rapidly expressed, and the tooth displaces within the PDL space, compressing the ligament itself against adjacent bone.

Pain is normally felt after 3 to 5 seconds of heavy force application, indicating that the fluids are expressed and crushing pressure is applied against the PDL in this amount of time.

Definition of Terms Related to Tooth Movement

Center of Resistance:

a point at which resistance to movement can be concentrated for mathematical analysis. The center of resistance for a tooth is at the approximate midpoint of the embedded portion of the root (i.e. about the halfway between the root apex and the crest of the alveolar bone)

Center of Rotation :

the point around which rotation actually occurs when an object is being moved.

Couple:

two force equal in magnitude and opposite in direction, a couple will produce pure rotation about the center of resistance.

- Type of orthodontic tooth movement

- **Extrusion:**

- A translational type of tooth movement parallel to the long axis of the tooth in the direction of the occlusal plane.

- **Intrusion:**

- A translational type of tooth movement parallel to the long axis of the tooth in the direction of the apical level.

- **Pure Root Movement:**

- The type of tooth movement for which the center of rotation is at the incisal edge.

- **Controlled Tipping:**

- A type of tooth movement consisting of rotation about the apex of the tooth.

Uncontrolled Tipping:

- Movement of the crown and the apex of the tooth in opposite direction.

- **Translation (Bodily movement):**

- All points on a tooth move in the same direction by the same amount.

- **Rotation Movement:**

- Movement of the tooth around its long axis by two forces equal in magnitude and opposite in direction.