Orthodontics

Orthodontic Tooth Movement

Phases of tooth movement:

Clinically, orthodontic tooth movement passes through three distinct phases:

1. Initial or displacement phase:

The initial reaction of a tooth following force application is almost instantaneous [within a fraction of a second] and may last for a few days; it reflects the immediate movement of the tooth within the viscoelastic PDL cradle. These movements are generally predicable by biophysical principles and typically do not involve extensive amounts of tissue remodeling or deformation of the investing alveolar bone. The fluid compartments within the PDL play an important role in the transmission and damping of forces acting on teeth.

2. Delay or Latency phase

Is characterized by the absence of clinical tooth movement but extensive remodeling occurs in all tooth investing tissues. Depending on the force magnitudes that result in localized compression of the PDL, there can be either PARTIAL or COMPLETE occlusion of the blood vessels in the area. Heavy forces have been shown to produce a log phase of up to 2l days before tooth movement, while optimal forces can reduce this phase to significantly less than 14 days.

3. Post-Lag or acceleration and linear phase:

It characterized by rapid tooth movement which is initiated in deference to the adaptation of the supporting PDL and alveolar bone changes achieved in the previous phases.

Rate of tooth movement:

It is defined as the displacement of a tooth per unit time, and is usually measured in mm per an hour, a day, a week, or a month. About 1mm per month may be regarded as an acceptable rate of tooth movement.

Rate of tooth movement is affected by many factors:

1. Force magnitude:

Tooth movement increases proportionally in relation to force up to a point, when it is reached; the amount of tooth movement becomes independent of the force magnitude (remains out about the same level over a fairly broad range), and then it may actually decline with extremely heavy forces. So, forces greater than that point (although equally effective in producing tooth movement) would be unnecessarily traumatic to biologic tissues and stressful to the anchorage.

The optimum force for tooth movement is around 20-25g/cm^2 of root surface area. The force magnitude applied to an individual tooth will depend upon its root surface area and the type of planned tooth movement. For example, in bodily-movement the force is spread over the whole of root surface in the direction of translation; thus a larger force is required to achieve the movement- in contrast, intrusion requires light forces as the applied stress is concentrated, at the root apex and applying an excessive force runs the risk of occluding the blood supply to the pulpal tissues.

Average forces for the common tooth movements are:

[The lower limit of the range is for incisors while the upper for molars]

- Intrusion 15-25g

- Tipping 30-60 g

- Extrusion 50-75 g

- Rotation 50-75 g

- Bodily 100-150 g

- Torque 120-160 g

The use of heavy forces in orthodontic tooth movement is not advocated for a number of reasons:

- Delay in tooth movement.
- Increased risk of anchorage loss.
- Increased pain and discomfort.
- Increased tooth mobility due to the removal of a greater amount of supporting bone.
- Loss of tooth vitality.
- Excessive root resorption.

2. Force duration:

The manner of orthodontic Force application is generally either intermittent [e.g. removable appliances] or continuous [e.g. fixed appliances]. The chemical mediators for tooth movement appear in the blood stream within movement occurs with force duration as little as 6 hours per day.

However, for optimal tooth movement, application of a light continuous force is preferable to intermittent forces because the cell biology system remains in a constantly responsive state; not fluctuating state.

Irregularities may be present in the bony socket wall; this means that even though if optimal force is applied, excessive forces may develop in small areas. To allow these areas to remodel properly, reactivation of the force exerted by an appliance must be done at intervals more than 3 weeks apart.

3. Age:

Tooth movement and biologic responses to orthodontic treatment in the adults are slower than in adolescents and children because the PDL is much less cellular in adults. In addition, the alveolar bone in adults is denser. Further reasons for more rapid teeth movement in children are:

- Physiological tooth movement is greatest when the teeth are erupting.
- Younger cells respond more quickly in reaction to a force.
- Growth can be utilized.
- The width of PDL is increased in newly erupted teeth, and so a greater force can be applied before constriction of the blood vessels occurs.

4. Occlusal interlock:

A good buccal occlusion may act to resist tooth movement. This may or may not be an advantage.

5. Individual variation:

Individual differences in rate of growth, bone density and metabolism, and tum over in the PDL may be responsible for the variation in rate of tooth movement.

6. Drugs and chemical agents:

Many studies have been conducted to test the accelerative or preventive effect of many drugs and chemical agents on orthodontic tooth movement, and it has been found that the rate of tooth movement can be altered by applying certain agents locally or systemically. The promoter agents accelerate the required tooth movement by enhancement of bone resorption; e.g. prostaglandins, Vitamin D, and corticosteroids. The suppressor agents reduce tooth movement by reducing bone resorption or enhancing bone formation and that is why they are important in anchorage and retention; e.g. NSAIDs and Bisphosphonates.

Notes:

- For the NSAIDs, only the acetaminophen [paracetamol] is safe analgesic that does not retard tooth movement.
- Orthodontic tooth movement is not limitless! i.e., careful treatment is always required since it is quite possible to move a tooth root through the labial or palatal cortical plate [fenestration].
- Within the same patient, the rate of orthodontic tooth movement may be different at the right and left sides.
- Endodontically treated teeth can undergo orthodontic movement, but light forces must be used.

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