BIOLOGY OF TOOTH MOVEMENT

Department of Orthodontics

Yes, I'm afraid he's going to need braces...

Learning Objectives

- To understand the physiology tooth movement
- To understand orthodontic tooth movment

Contents

- Introduction
- Periodontal ligament
- Structure
- Functions
- Composition
- Physiologic tooth movement
- Orthodontic tooth movement

Introduction

Orthodontic tooth movement is a **unique** process where a solid object (tooth) is made to move through a solid medium (bone).

Orthodontic treatment is possible due to the fact that **whenever a prolonged force is applied on a tooth,bone remodelling occurs around the tooth resulting in its movement**.

Bone subject to **pressure** as a result of **compression** of periodontal ligament **resorbs**. While, bone **forms** under **tensile** force, as a result of **stretching** of periodontal ligament.The bony response is mediated by the **periodontal ligament**, Tooth movement is primarily a periodontal ligament phenomenon.

Structure of periodontal ligament:

The PDL occupies a space approximately 0.5mm in width around all parts of roots.

Major component of the ligament are:-

1. **Network of parallel collagenous fibers.**
2. **Cellular elements along with vascular and neural elements.**
3. **Tissue fluids.**

- **The cellular element and fluid play an important role in normal function and in making orthodontic tooth movement possible.**

I.Physiologic Tooth Movement

- **Naturally occurring** tooth movements that take place during and after tooth eruption.

This include:

- **A)Tooth Eruption**.
- B)**Migration** or drift of teeth.
- C)**Changes** in tooth position **during mastication**.

TOOTH ERUPTION:

- Tooth eruption is the **axial movement** of tooth from its development position in the jaw to its final position in the oral cavity.
- The following are some theories which explains the eruption process.
- **a)Blood pressure theory:**

According to this theory,the tissue around the developing end of the root is highly vascular.This vascular pressure is believed to cause the axial movement of teeth.

b)Root Growth:

- According to this theory,the apical growth of roots result in an axially directed force that brings about the eruption of teeth.
- This theory was rejected because:

The tooth moves at a greater distance than the root length.

Onset of root growth and eruption do not coincide.

Teeth without roots also erupt.

c)Hammock ligament theory:

- According to Sicher, a band of fibrous tissue exists below the root apex spanning from one side of alveolar wall to other. This fibrous tissue appears to form a network below the developing root and is rich in fluid droplets.the developing root forces itself against this band of tissue, which in turn applies an occlusally directed force on tooth.

- **d)Periodontal traction theory:**

This theory states that the periodontal ligament is rich in fibroblasts that contain contractile tissue.The contraction of these periodontal fibers (mainly the oblique group of fibers) results in axial movement of the tooth.

B) Migration or drift of teeth:

- Refers to the minor changes in tooth position observed after eruption .
- Human dentition shows a natural tendency to move in a mesial & occlusal direction.
- Usually a result of proximal and occlusal wear of teeth,
- They move in a mesial and occlusal direction to maintain inter-proximal and occlusal contact.

C)Tooth movement during mastication:

- During mastication ,the teeth and PDL structures are subjected to intermittent heavy forces which occurs in cycles of one second or less and may range from 1-50 kg based on the type of food being masticated.

Physiologic response to heavy pressure against a tooth:-

- <1 sec – PDL fluid incompressible, alveolar bone bends, piezoelectric effect.
- 1-2 sec – PDL fluid compressed, tooth moves within the PDL space.
- 3-5 sec – PDL fluid squeezed out, tissue compressed, immediate pain.

II.Orthodontic Tooth Movement

- It is a pathological process from which the tissue recovers.

Histology of tooth movement:

- Orthodontic movement bring about areas of pressure and tension around the tooth. The histologic changes seen during tooth movement vary according to the amount and duration of force applied.

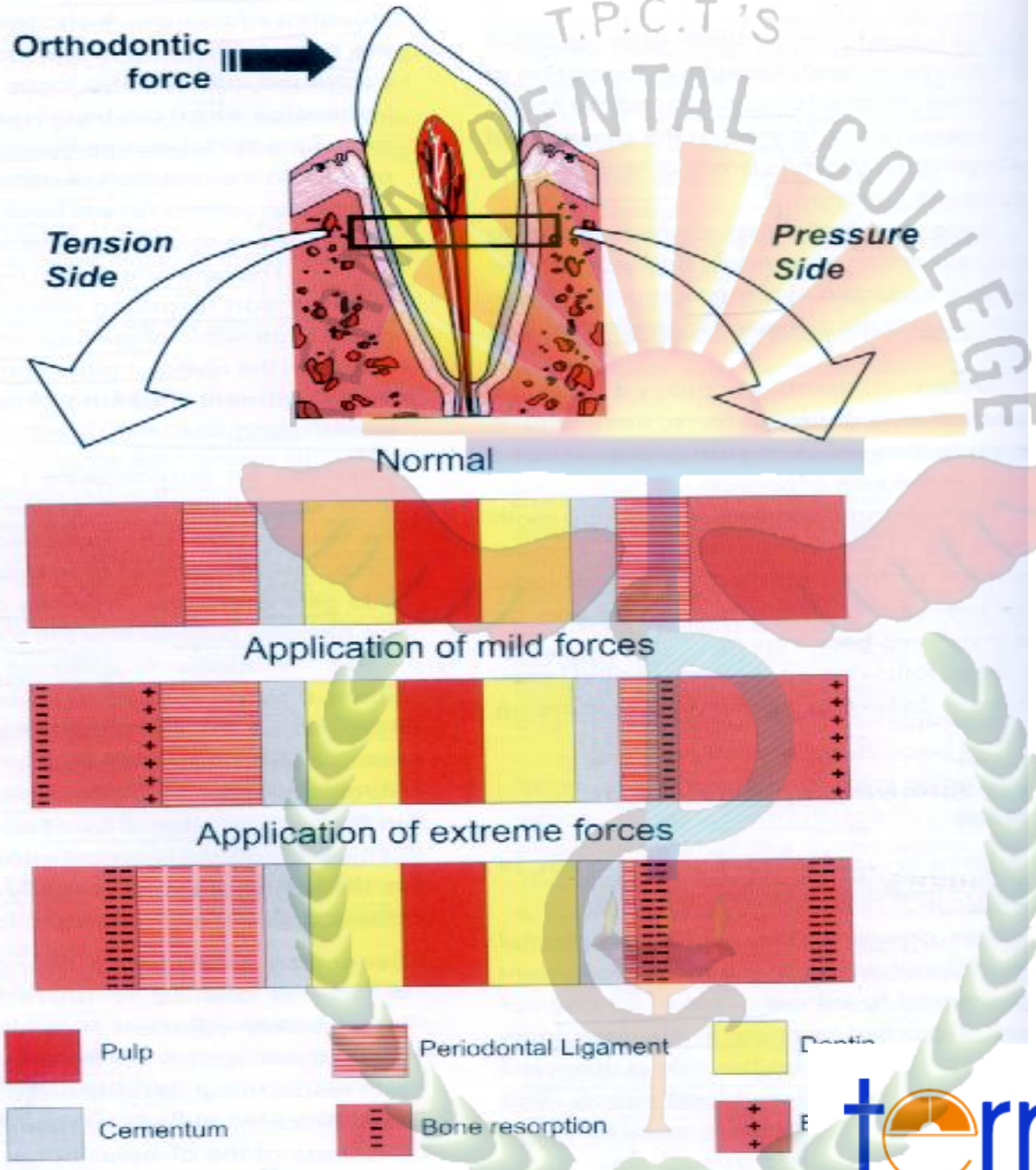


Fig 1 Histology of tooth movement

Changes following application of mild forces:

- Classically the movement of teeth has been explained via the pressure:tension hypothesis in which PDL tissues in pressure side results in bone resurption , while placing the PDL tissues under tensile force lead to bone deposition.

Changes on pressure side:

- The PDL in direction of tooth movement gets compressed to almost 1/3rd of it's original thickness.
- A marked increase in the vascularity of PDL on this side is observed due to increase in capillary blood supply.
- This increase in blood supply helps in mobilization of cells such as fibroblasts and osteoclasts.
- Osteoclasts are bone resorbing cells that lie in Howship's lacunae .
- when forces applied are within physiologic limits,the resorption is seen in alveolar plate immediately adjacent to the ligament.This kind of reorption is called frontal resorption.

Changes on tension side:

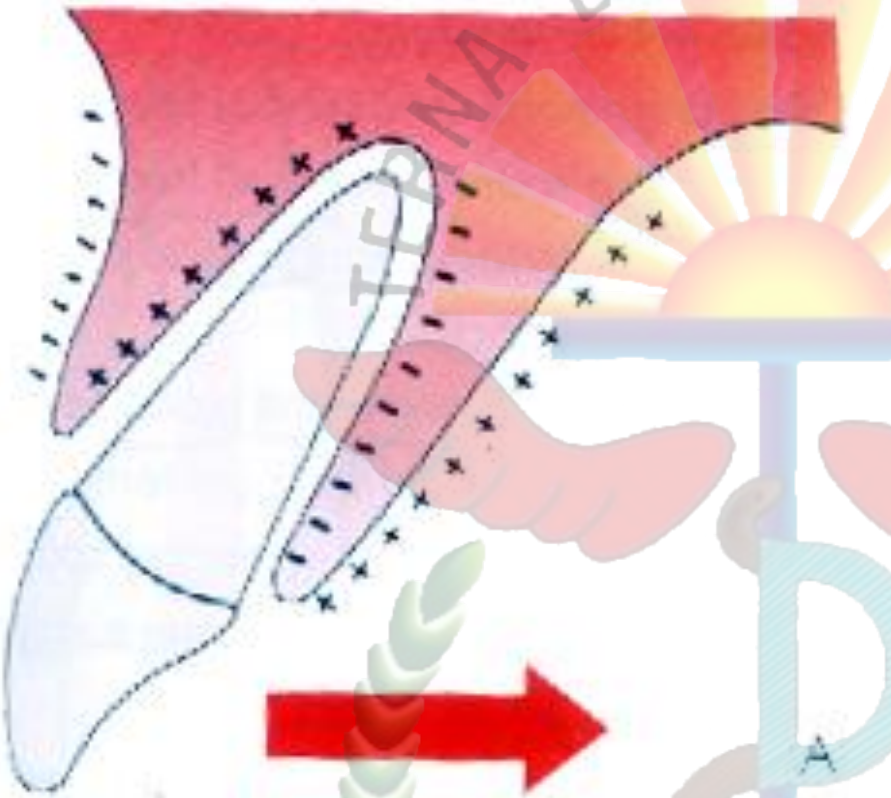
- PDL stretched
- Distance between alveolar process & tooth is widened.
- Increased vascularity.
- Mobilization of fibroblasts & osteoblasts.
- Osteoid is laid down by osteoblast in PDL immediately adjacent to lamina dura.
- Lightly calcified bone mature to form woven bone.

Secondary remodelling changes:

- **Bony changes also takes place elsewhere to maintain the width or thickness of alveolar bone.These changes are called secondary remodeling changes.**

For eg:-If a tooth is being moved in a lingual direction there is compensatory deposition of new bone on the outerside of the lingual alveolar bony plate and also a compensatory resorption on the labial side of the labial alveolar bone.

This is to maintain the thickness of the supporting alveolar process .



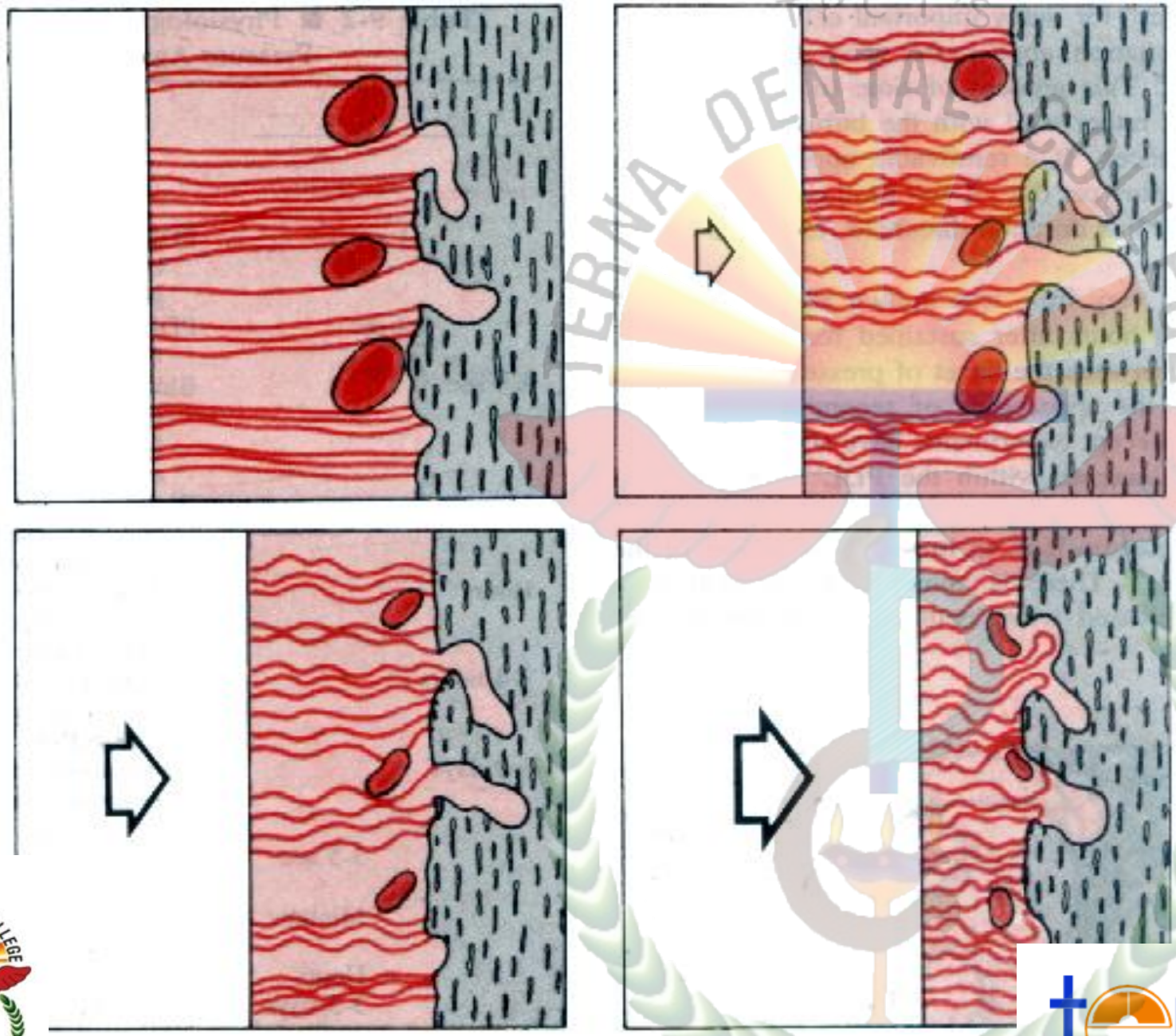
Change following application of extreme forces:

On the pressure side :-

- **Root closely approximates the lamina dura .**
- **Compresses the PDL and leads to occlusion of blood vessels.**
- **The PDL is hence deprived of its nutritional supply leading to regressive changes called hyalinization .**
- **Underminig/Rearward resorption occurs in the adjacent marrow spaces and alveolar plate below, behind & above the hyalinized zone.**

On the tension side:-

- Over stretched PDL .
- Tearing of blood vessels & ischaemia.
- Extreme forces applied net increase in osteoclastic activity and tooth loosened in socket.



Optimum orthodontic force:

- **Is one which moves teeth most rapidly in the desired direction ,with the least possible damage to tissue and with minimum patient discomfort.**
- **Schwarz proposed the classic concept of the optimal force. He defined optimal continuous force as the force leading to a change in tissue pressure ,that approximated the capillary vessel & blood pressure.Thus preventing their occlusion in the compressed PDL.**
- **Below the optimal level cause no reaction in PDL.**
- **Forces exceeding optimal level would lead to areas of tissue necrosis ,preventing frontal bone resorption.**

- **Schwarz's definition was slightly modified by Oppenheim who advocated the use of lightest force capable of bringing about tooth movement.**

- **Oppenheim and Schwarz following extensive studies state that the optimum force is equivalent to the capillary pulse pressure which is 20-26gm/sq.cm of root surface area.**

From a clinical point of view,Optimum orthodontic force has the following characteristics:

- **Produce rapid tooth movement.**
- **Minimal patient discomfort.**
- **The lag phase of tooth movement is minimal.**
- **No marked mobility of the teeth being moved.**

From a histological point of view the use of optimum force has the following characteristics:-

- **The vitality of the tooth and supporting PDL is maintained.**
- **Initiates maximum cellular response.**
- **Produces direct or frontal resorption**

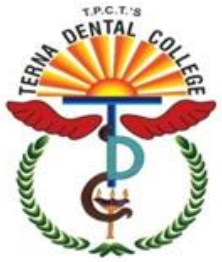
Take Home Points

The clinician needs to understand the role of peridontium in mechanism of tooth movement and the changes taking place on cellular level.

The optimum orthodontic force required for tooth movement which is faster ,healthy for the peridontium and least time consuming.

- SAQ
- 1)secondary remodelling changes
- 2)Frontal vs Undermining resorption
- 3)Mild force vs Exgtreme force
- 4)Optimum Orthodontic Force
- LAQ
- What Is Optimum Orthodontic tooth force?Explain the histological and clinical characterstics of Optimum of Orthodontic Force?

THANK YOU



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