APEXOGENESIS & APEXICIFICATION

CONTENT

- Introduction
- Causes of open apex
- Problems faced with open apex
- Types of open apex
- Classification of open apex
- Apexogenesis
  - Goals of apexogenesis
  - Procedure
- Apexification
  - Technique
  - Calcium Hydroxide
  - MTA

INTRODUCTION

Definition – open apex

Absence of sufficient root development to provide a conical taper to the canal and is also referred to as blunderbuss canal. (Franklein S. Weine 1972)

Due to trauma or carious exposure, the pulp undergoes necrosis, dentin formation ceases and root growth is arrested. The resultant immature root will have an apical opening that is very large. This is called an open apex, also referred to previously as a blunderbuss canal. . (Thomas R.Pittford,1989)

Causes of Open Apices

The open apex typically occurs when the pulp undergoes necrosis as a result of caries or trauma, before root growth and development are complete

An open apex can also occasionally form in a mature apex as a result of extensive apical resorption due to orthodontic treatment, periapical pathosis or trauma and over instrumentation during conventional root canal therapy.

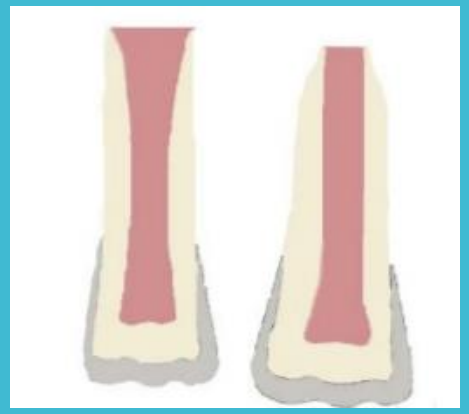
Problems faced with open apex

Due to large apical diameter and smaller coronal canal diameter debridement is difficult.

Lack of apical stop makes working length determination and obturation difficult.

The thin root canal walls are always prone to fracture

Types of open apices



NON-BLUNDERBUSS
Broadly opened apex (Cylinder – shaped root canals).

The walls of the canal may be parallel to slightly convergent as the canal exits the root

BLUNDERBUSS
Funnel shaped apex (Apical opening can be wider than the coronal root canal orifice (inverted root canal conicity)

The walls of the canal are divergent and flaring, more especially in the buccolingual direction

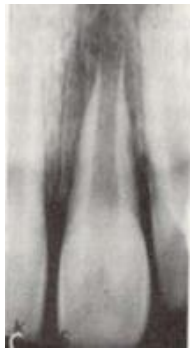
Stages Of Root Development

According to the width of the apical foramen and the length of the root, Cvek has classified 5 stages of root development

Stage 1 Teeth with wide divergent apical opening and a root length estimated to less than half of the final root length.

Stage 2 Teeth with wide divergent apical opening and a root length estimated to half of the final root length.

Stage 3 Teeth with wide divergent apical opening and a root length estimated to two thirds of the final root length.



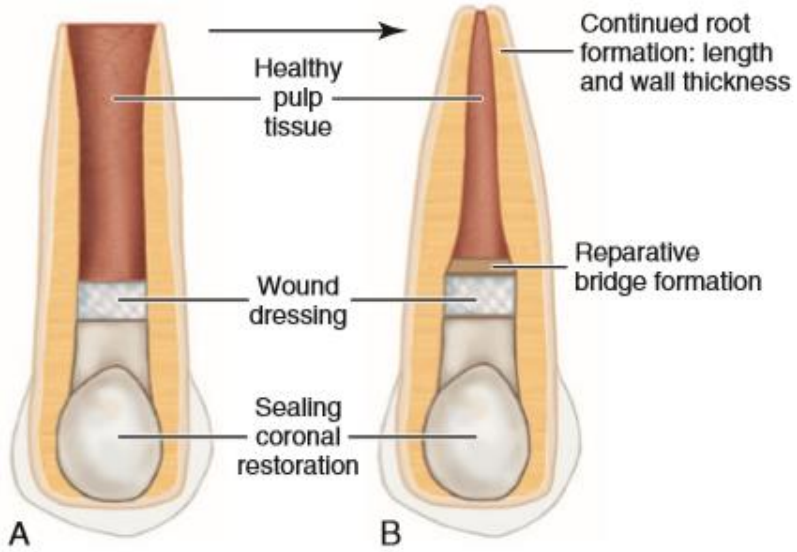
Stage 4 Teeth with wide open apical foramen and nearly completed root length.

Stage 5 Teeth with closed apical foramen and completed root development

Apexogenesis

Apex=root end, genesis=formation.

Apex genesis is defined as “a vital pulp therapy procedure to encourage continued physiological development and formation of the root end”



Goals of apexogenesis

Stated by Webber are as follows:

- ✓ Sustaining a viable Hertwig's sheath, thus allowing continued development of root length for a more favorable crown-to-root ratio.
- ✓ Maintaining pulpal vitality, thus allowing the remaining odontoblasts to lay down dentine, producing a thicker root and decreasing the chance of root fracture.
- ✓ Promoting root end closure, thus creating a natural apical constriction for root canal filling.
- ✓ Generating a dentinal bridge at the site of the pulpotomy.

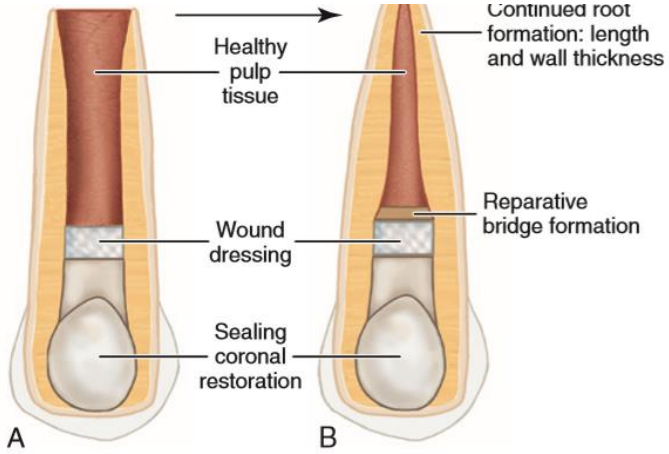
Procedure

Deep resection of pulp tissue is usually undertaken in single-rooted anterior teeth with a small endodontic spoon excavator or round, abrasive diamond bur

Bleeding is usually controlled with saline-soaked cotton pellets or NaOCl

The pulp wound is then covered with a dressing material before the crown is securely restored

Radiographic and clinical follow-up is mandatory, and if there is no evidence of continued root formation and calcific barrier formation - apexification or a regenerative technique may be considered.



Materials

Based on the depth at which this procedure is performed, preference has usually been given to the use of Ca(OH)2 rather than MTA because, in the event of failure, this may facilitate re-entry to the root canal to perform apexification or pulp regeneration

Small increments of Ca(OH)2 powder are carefully placed against the entire surface of the pulp stump with a rounded-end, plastic instrument.

Care must be taken not to pack the Ca(OH)2 into the pulp tissue because this causes greater inflammation and increases the chances of failure.

Treatment of necrotic pulp with open apex

(1) filling the root canal with the large (blunt) end of a gutta-percha cone or customized gutta-percha cones with a sealer

(2) filling the root canal well short of the apex (before the walls have diverged) with gutta-percha and sealer or zinc oxide eugenol (ZOE) alone

(3) filling the root canal with gutta-percha and sealer as well as possible and then performing periapical surgery with or without a reverse seal

(4) inducing apical closure by the formation of an apical stop (calcium hydroxide [Ca(OH))] is generally used) against which a permanent root canal filling can subsequently be inserted and

(5) placing a biologically acceptable substance in the apical portion of the root canal (dentinal chips or tricalcium phosphate have been used)

Blunt-end or rolled cone

Filling the root canal with the large end of a gutta percha cone or a customized cone is not advisable because the apical foramen - generally wider than the root canal orifice

Prevent proper condensation of the gutta-percha, and proper preparation of the canal would weaken the tooth considerably.

Short-fill

Moodnick proposed removal of the bulk of the necrotic tissue and filling the root canal short of the apex with gutta-percha.

He advocated use of Diaket (Premier Dental Products), a compound of beta-ketones and zinc oxide, in place of gutta-percha to enhance healing.

Incomplete obturation- microbes can be left remaining within the apical part of the root canal system, and healing may not take place or periapical breakdown may occur later

Periapical surgery

Many clinicians do not advocate this method of treatment for one or more of the following reasons:

1, Relative to the already shortened roots, further reduction could result in an inadequate crown-to-root ratio.

2, Surgery could be both physically and psychologically traumatic to the young patient

3, The young patient is not apt to be cooperative

4, Surgery would remove the root sheath and prevent the possibility of further root development

5, The apical walls are thin and could shatter when touched by a rotating bur

6, The thin walls would make condensation of a retrograde material difficult. - inadequate seal

Apexification

Apexification, or root-end closure, is the process in which a nonvital, immature, permanent tooth that has lost the capacity for further root development is induced to form a calcified barrier at the root terminus - Ingle

“a method to induce a calcified barrier in a root with open apex” – Mass et al (2011)

Indications

a. Permanent teeth.

b. Non vital pulp with open apex and thin dentin walls.

Technique

The tooth should be isolated with rubber dam.

The first phase of treatment is to disinfect the root canal system

The canal length is estimated with a preoperative radiograph, and after access to the canals is made, a file is placed to the determined length and the working length is confirmed by radiograph.

Very light filing with copious irrigation using 0.5% sodium hypochlorite is performed.

The canal is dried with paper points

Creamy mix of calcium hydroxide is placed against the apical soft tissue and backfilled the canal till the canal orifice and seal with temporary restoration

A radiograph is taken in order to evaluate the formation of hard tissue barrier and washout of CH

Sheehy EC et al , Chawla et al , Cveck et al suggested placing the paste only once and waiting for radiographic evidence of barrier formation, and that there was nothing gained by repeated root filling either monthly or after three months

When hard tissue barrier is indicated on radiograph, the calcium hydroxide is washed out with sodium hypochlorite and apical barrier is detected gently by a file or a paper point.

The entire canal is then filled with thermoplasticized gutta percha

One step/visit apexification

MTA should be mixed to a thick creamy consistency and placed 1-1.5 mm short of working length using a carrier and condensed with minimal pressure. This is repeated until approximately 5mm of material is deposited apically.

Moist cotton is placed in the canal for at least 6 hours and the entire canal is filled with thermo plasticized gutter perch or the root filling is placed immediately over MTA because the tissue fluid of the open apex will probably provide enough moisture for MTA to set.

Care must be taken to avoid excessive lateral forces during obturation technique

Mode of action

Calcium hydroxide and mineral trioxide aggregate stimulate

Release of growth factors and bioactive molecules from cemented matrix

Signal progenitor/stem cells in periodontal ligament to differentiate into cement oblast-like cells that forms cemented tissue – kinirons MJ

Calcium Hydroxide

When CH is placed against periodontal tissues- the high PH value of CH

↓

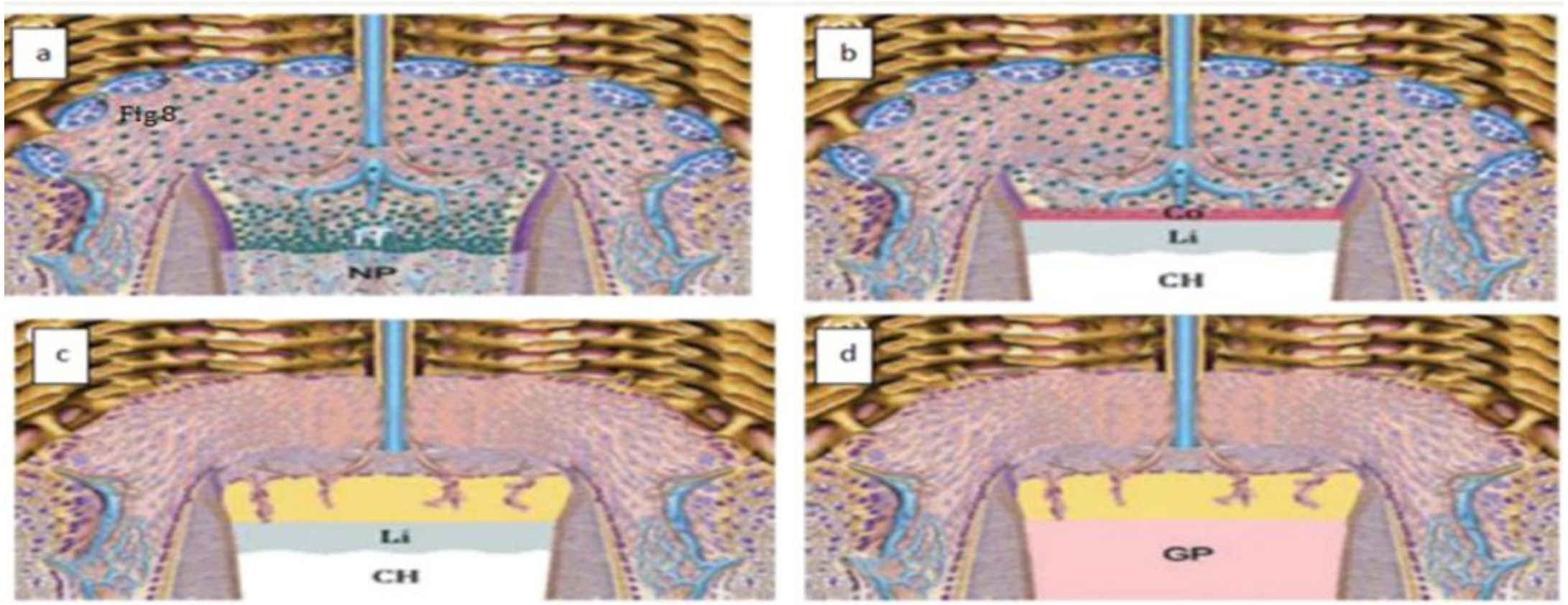
Zone of liquefaction necrosis subjacent to CH and a deeper zone of coagulation necrosis next to periodical tissues .

↓

Coagulation necrosis zone stimulates release of growth factors (wound healing signals) and bioactive molecules from cemented matrix and alveolar bone marrow matrix.

↓

The response to these factors appear to be recruitment of new hard tissue forming from apical tissue, these are usually of cementoblastic but may also be osteoblastic origin



Calcium hydroxide

There are several limitations in Ca(OH)2 induced apexification procedure, that include :

Unpredictable and lengthy course of treatment leading to the vulnerability of the temporary coronal restoration to re-infection (Magura et al 1991).

Multiple visits involved in this treatment requires a high level of patient compliance

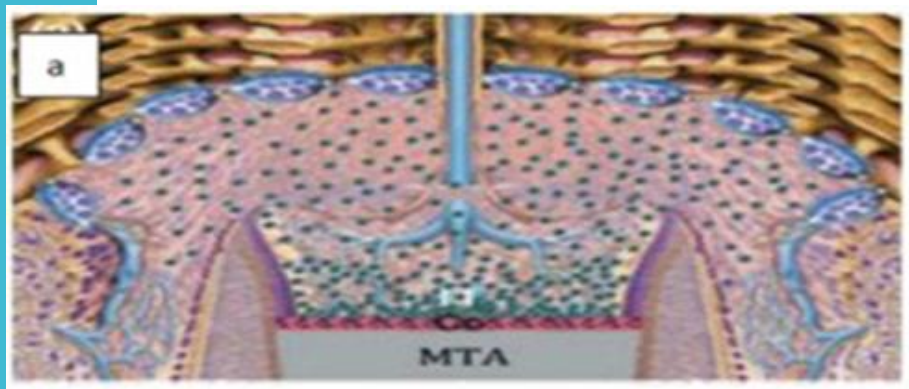
Long term intra canal Ca(OH)2 dressing can also make the tooth brittle because of its hygroscopic and proteolytic properties

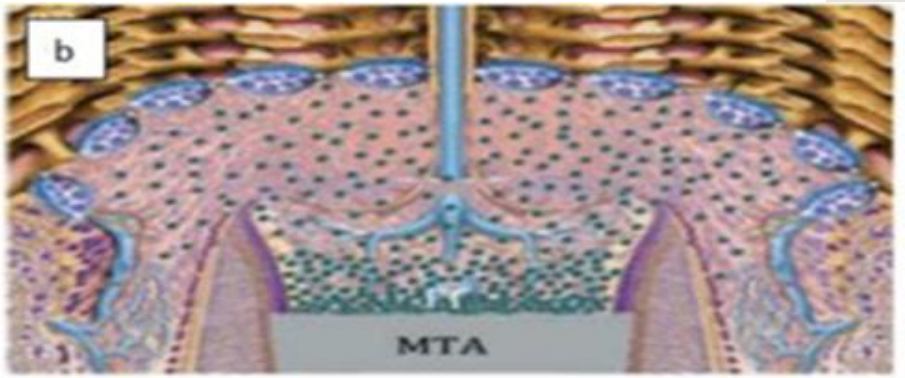
MTA

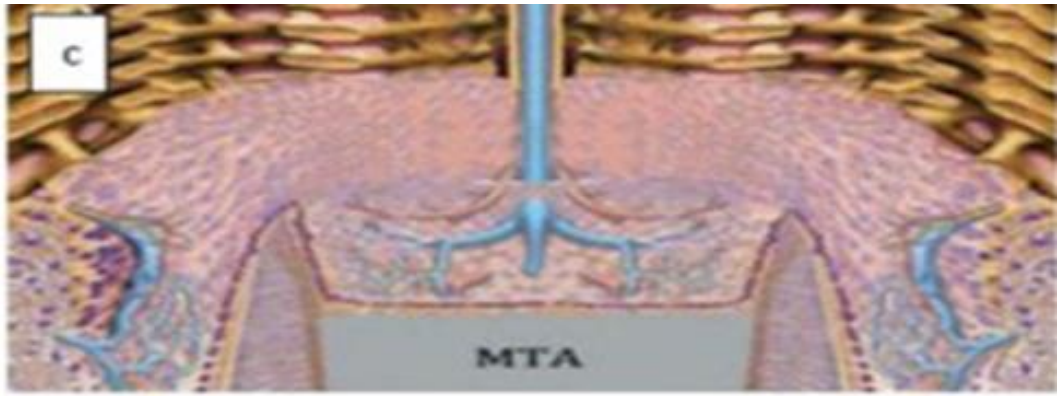
When MTA is placed against periodontal tissues - the high PH value of MTA

Very narrow zone of coagulation necrosis next to periodontal tissues

MTA modulates cytokines production and encourages differentiation and migration of hard tissue producing cells- hydroxyapatite is formed on MTA surface and biological seal is created


a
MTA


b
MTA


c
MTA

Biodentine

In 2009 Biodentine (Septodont, St Maur des Fosses, France) was introduced as a tricalcium silicate cementum.

Powder capsules composed of tricalcium silicate, calcium carbonate, and zirconium oxide
Liquid containing water, calcium chloride to accelerate setting.

Biodentine has a shorter setting time of 12 minutes

Biodentine - lack cytotoxicity, and it is able to stimulate collagen fiber and fibroblast formation

Induce stem cells from apical papilla and signaling factors to specific cell differentiation pathway

The calcium ions and presence of Si-OH groups of calcium silicate cements induce apical sealing through the deposition of apatite onto the surface of the root cement