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PHYSIOLOGICAL AND PATHOLOGICAL PULP CANAL OBLITERATION BY CALCIFIC METAMORPHOSIS-A REVIEW

Running title: Pulp canal obliteration- a review

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ABSTRACT
Calcifications are common in the dental pulp, with a tendency to increase with age and irritation. Deposition of hard tissue in pulp canal space increases dentinal thickness and cause yellowish discoloration of tooth. Almost all pulp canal obliterated cases remain asymptomatic and often there is dilemma on treating such cases. Most of the clinicians face serious difficulties causing iatrogenic errors like perforation, root fracture, gouging and instrument fracture in treating such cases. The use of CBCT, magnification, DG 16 explorer and ultrasonic tips help in the location of orifices. Pulp sensibility test may give a false negative response. A thorough knowledge on root canal anatomy and variations along with operators experience play an important role in endodontic treatment of pulp canal obliteration.

Keywords: Calcific metamorphosis, Pulp stones, Perforation, Cone beam computed tomography, Guided endodontics, Ultrasonic tips

INTRODUCTION
The process by which tissue becomes hardened due to of precipitation of large deposits of insoluble calcium and magnesium salts of calcium, especially calcium carbonate and phosphate is known as calcification. Calcifications are common in the dental pulp, with a tendency to increase with age and irritation[1].American Association of Endodontists have defined Calcific Metamorphosis[2]as “A pulpal response to trauma characterizedby rapid deposition of hard tissue within the canal space”. These pulp stones are most commonly seen in the coronal portion of the teeth. Epithelial strands detach from the enamel organ and become isolated in the dental papilla where they interact with the ectomesenchyme resulting in the differentiation of odontoblasts around the strands.

It deposits dentin as they move away from this epithelium and resulting structures are hollow thimble shaped with facing concavities apically. These structures are called denticles and they are formed before or during tooth development. Calcified masses that are formed after tooth development are called as pulp stones. Initially pulp tissue components such as collagen fibril, ground substance and other pulp cell remnants serve as a focus upon which calcified material is subsequently deposited in a concentric lamellar or radial fashion resulting in the formation of pulp stones. The pulp stones size increase by gradual deposition of calcified material layers over the surface of the irregular calcified nidal core[3]. These calcified canals appear laminated when viewed light microscopically. Radiographically absence of pulp canal space is a representative feature of pulp canal obliteration. Absence of a pulp canal space in a radiograph does not mean complete obliteration of root canal. In many cases very fine pulp canal space with remnants of pulp tissue can be present and these remnants may harbour millions of microorganisms. Almost more than 75% of teeth with calcific metamorphosis are asymptomatic and often there is a dilemma whether they require an endodontic treatment. These calcified canals pose serious challenges to all dentists in cleaning and shaping. Endodontic mishaps like gouging, perforation, instrument fracture are most likely to be occur in such cases. Hence endodontic therapy is usually indicated in teeth with obliterated pulp canal only when associated with clinical or radiographic features of periapical disease[4].

Mechanism of calcification

Calcific metamorphosis is generally initiated by stimulation of osteoblastic activity. It is characterized by an osteoid tissue that is produced by the odontoblasts at the periphery of the pulp space which results in simultaneous deposition of dentin like tissue. Robertson observed calcific metamorphosis in patients who have suffered concussion or subluxation injuries and concluded obliteration to be either dentine like, bone like or fibrotic in primary teeth[5]. On histological examination Holan found tube-like structuresof osteodentine along with cellular inclusions in deciduous teeth[6]. Lundberg and Cvek concluded in their study that the tissue changes in permanent maxillary incisors were characterized by increase in the collagen content and also marked reduction in the number of cells[7]. Adjacent to the mineralized areas, they also found osteoid tissue with cellular inclusions. The rate of deposition of dentin like tissue is uncontrolled and it could be as high as 3.5 μm per day[8]. Calcific metamorphosis may occur due to injury to the neurovascular supply of the pulp. Few authors have concluded that intracanal bleeding and blood could serve as a focal point for calcification if pulp remains vital after trauma. Therefore traumatic injuries may not be sufficient enough to cause necrosis of pulp, thereby leading to calcific metamorphosis. After hyaline degeneration due to compromised circulation, fat droplet deposition and fibrosis of pulp there occurs mucoid degeneration that ultimately leads to calcification. Bases instead of protecting the dental pulp, cause irritation leading to the stimulation of secondary reparative dentine formation. Dental cements such as silicate and glass ionomer cement act as irritant because of its acidic pH. They sometimes cause atrophy, pulposis and premature aging of the pulp. Following pulpotomy and direct pulp caping a high incidence of pulp canal obliteration has been observed. Local conditions such as pH level, the activity of carbonic anhydrase and phosphate concentration probably act to accelerate the rate of deposition [9].

Calcification due to aging

Teeth aging occurs not only with the passage of time but also under the stimulus of function and irritation. Age is a chronologic occurrence and also an “aged” tooth may

represent a premature response to the abuses of caries, extensive restorative procedures and inflicted trauma. Pulp responds to abuses by altering the anatomy of its internal structures and surrounding hard tissue as it reacts to its environment and also is in intimate contact with dentin. Pulp volume and cells, its blood vessels and nerves decrease and fibrous component increases as age of the tooth increases thereby resulting in calcification[9].

Calcification due to mineralisation in response to various irritants

- Chronic trauma such as attrition and abrasion
- Dental caries and deep restorations
- Poor control of orthodontic forces
- Medicaments
- Genetics
- Traumatic injuries

Pulp Stones

The pulpal calcifications are identified as focal intrapulpal radio-opacities in pulp chamber or as diffuse radio-opacities in the root canal giving an appearance of' calcific obliteration. Routinely dental periapical radiographs or bitewing radiographs are used to demonstrate pulp stones. In microradiographs, the masses of calcified bodies shows homogenous radio-opacity or heterogeneous globular structure of highly mineralized material generally more opaque than the osteodentin[10]. Pulp stones are considered to be important by the clinician who attempts access cavity preparation or to negotiate canals. It may attain large size and occupy considerable volume of the coronal pulp. Pulp stones can alter the internal anatomy of the root canal and also confuse the operator by obscuring without totally blocking the orifice of the canal. The attached denticles may deflect or even engage the tip of instruments exploring inside the root canals, thereby preventing their easy passage down the root canal. The large, discrete masses, occasionally appearing to nearly fill the chamber, are likely to be those of natural occurrence. The pulp chamber which has a diffuse and obscure outline represents a dental pulp that has been subjected to persistent irritant and these pulp respond by formation of large numbers of irregular pulp stones[11]. This finding serves as a diagnostic aid and helps in detecting whether a pulp is exposed to a persistent chronic irritant or not.

Radiographic and Clinical features

Pulp canal obliteration are often observed as absence of the pulp chamber in periapical radiographs. Lamina dura remains intact without any widening of periodontal ligament space unless there is an evidence of periapical bone involvement. Radiographically calcific metamorphosis can be classified[1] as either:

- Partial Obliteration – Pulp chamber will be visible and the root canal becomes narrow but visible.
- Total Obliteration – the pulp chamber and canal is completely mineralized and is not visible.

It is usually asymptomatic with yellow discoloration of the coronal part of the tooth clinically due to an increase in the dentin thickness. It usually occurs in anterior teeth and can be recognized by the end of 3rd month or may also remain undetected upto1 year. Pulp sensibility test may reveal false negative test despite the presence of vital pulp due to increased dentin thickness and hence it is not reliable [12].

Management

Endodontic therapy for management of pulp canal obliteration showing no signs of pathosis or pain is always a dilemma. RCT is advised in these cases because of reduced cellular content leading to decreased ability for healing therefore making the pulpal tissue more susceptible to infection. If discoloration is the only concern for the patient, a vital bleaching is suggested. In case of irregular reparative dentin formation, intentional root canal treatment followed by non vital bleaching is done [13]. Proper and thorough knowledge about root canal anatomy, laws of orifice location and symmetry is very much necessary to achieve good endodontic therapy. A conservative access cavity preparation should be done and change in dentin color should indicate the position of the canal. A methylene blue dye or champagne bubble test can be used to locate the orifice. DG-16 endodontic explorer can be very helpful in location of the orifices. Long-necked round drills commonly known as LN bur and Munce burs may be used with gentle brushing strokes to negotiate these calcified canals. A sharp edge is made by cutting 4 mm of #30 or #35 size k file and this working end is used in reaming motion to remove hard debris. This is called as Modified Tip Instrument technique[14]. Mueller bur and ultrasonic tips have high significance in calcified canals. These have a advantage over the other bur because of its high cutting efficiency without rotation that enhances its safety and control, thereby reducing the risks of endodontic mishaps[15]. Micro openers and debriders can also aid in gaining access into calcified canals[16]. They improve operator efficiency by removing the fingers that obstruct field of vision when treatment is done under the microscope. Lateral radiographic technique can be applied to check for deviation of bur thereby avoiding the risk of perforation. In a calcified tooth CBCT plays an important role in determining the extent, nature and depth of calcification and also can guide the dentist to access the patent part of the canal[17]. Recent advances such as Guided endodontic access has made it easier for the clinicians. With the help of special software, alignment with a CBCT and surface scan allows virtual planning of an ideal endodontic access cavity. A guide template can be produced using a 3D printer. This template serves as a guide and helps to prepare a minimally invasive drill to the calcified root canal. Guided endodontics thereby allows a more predictable and expeditious location and negotiation of calcified root canals with significantly less substance loss irrespective of the operators experience[18].

After initial canal negotiation, #8 or #10 size k file should be used in watch winding motion with slight vertical pressure. The file should be removed, the orifice should be irrigated and then the file can be replaced to the same depth. As the irrigant penetrates into this small opening, the files will loosen debris and begin to create a coronal pathway to the middle portion of the canal[19]. A crown down approach is done with copious irrigation with 5.25% sodium hypochlorite. This procedure is repeated slowly until file reaches the working length[20].

CONCLUSION

Calcific metamorphosis can pose great challenges to practitioners. A thorough knowledge about root canal anatomy, laws of orifice location and symmetry is mandatory for any operator to achieve success in treating calcified canals.Early recognition of pulp canal obliteration using radiographs can save much time and avoid procedural errors. Root canal therapy is usually done only in calcified canals with pain or pathosis. Surgical intervention may be advised if orthograde treatment is not possible or failure of other treatment modalities.

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