Review Article

CHANNELS TO CRUISE THE CALCIFIED CANAL

Sridevi N, Puspha S, Iqbal M, Prasad A, Singh P, Singh R

ABSTRACT: Partial or total pulpal canal obliteration is a common sequel of a traumatic injury. It is characterized by apparent loss of the pulp space radiographically and a yellowish discoloration of the clinical crown. Approximately 7–27% of teeth with partial canal obliteration develop pulp necrosis with radiographic signs of periapical periodontitis. These teeth provide an endodontic treatment challenge; the critical management decision being whether to treat these teeth endodontically immediately upon detection of the pulp canal obliteration or to wait until symptoms or signs of pulp and or periapical disease occur. Negotiating obliterated canals could be from difficult to nearly impossible. Procedural mishaps such as perforation and instrument separation are encountered while negotiating these canals. Under the magnification provided by a dental operating microscope the whole procedure of dealing with obliterated canals could become very predictable. This article reviews the etiology, prevalence, classification, mechanism, diagnosis as well as treatment options for teeth with calcified canals.

Keywords: Pulp Obliteration; Calcific Metamorphosis; Pulp Stones; Reparative Dentin; Operating Microscope; Patency Files.

Introduction

Calcific metamorphosis or pulp canal obliteration is a pulpal response to trauma that is characterized by rapid deposition of hard tissue within the root canal space.[1]This is a slow, normally occurring physiological aging process. Hard tissue deposition occurs in response to tooth wear, at a slow pace. The exact mechanism of canal obliteration is unknown but is believed to be related to damage to the neurovascular supply of the pulp at the time of injury.[2] Calcified canals in need of root canal treatment pose certain treatment challenges.[3] The recent advances in the field of imaging, magnification and novel instruments aid in negotiating and managing these calcified canals efficiently without any procedural mishaps. This article is designed to help the clinician to understand the etiology, diagnosis and treatment options of the calcified canals.

Etiology

The possible etiological factors resulting in pulp canal obliteration are prolonged trauma, natural process of aging, gender, various systemic diseases, non-vital tooth without endodontic treatment, long-term irritation such as dental restorations and crowns that exert constant force on the tooth. Age changes such as reduction in size of pulp due to secondary dentin deposition, occur throughout life resulting in reduction in root canal length and width. In addition, the blood supply decreases with age. The pulp horns and the floor and roof of the pulp chamber in molars, may be converted from a large rectangular cavern in the young, to a flat disc in the elderly.[3]This diminished pulp space occurs throughout life by the deposition of secondary dentine. In roots, deposition is always concentric towards the center of the mass of dentine. Deposition is often most marked in the coronal reaches of the canal system, with deeper areas of root canals remaining widely patent even into very old age. Pulp space is further reduced by reactionary and reparative dentine which is laid down to reduce the porosity of dentinal tubules opened to the mouth by caries, trauma or dental treatment, or to heal frank pulpal exposures.[4]

Generalized pulp obliteration also been seen though it has not been established scientifically in certain diseases like Marfan syndrome and in renal osteodystrophy and atherosclerosis.[5]Andreasen (1987)[6]reported an increased incidence of pulp obliteration after orthodontic band fixation of traumatized teeth, and they assumed that band application might

have caused displacement of root with compression of the apical vessels. Pulp canal obliteration was found in all luxation categories, and 69% of the teeth demonstrated yellow crown discoloration.[7] It was observed that calcific metamorphosis developed more in teeth with concussion and subluxation injuries. The frequency of pulp obliteration is dependent on the extent of the luxation injuries and the stage of root formation.[8] It has been seen that in teeth with closed apices, there is constriction of blood vessels leading to pulpal necrosis, whereas if the apices are open, the tooth will react with increased deposition of sclerotic dentin. Restorative materials can also have an effect on the underlying pulp resulting in odontoblastic injury.

Types of calcification

Pulp stones or denticles are the calcifications that occur in the coronal region. According to morphology; the pulp stones are classified as true or false. True pulp stones have dentinal tubules like dentin, odontoblastic processes, and few odontoblasts, whereas false pulp stones are concentric layers of calcified tissue with a central cellular area, which might be necrotic and acts as nidus of pulp stone formation. According to their location; they can be classified into embedded, interstitial, adherent, and free denticles.[9]

The degree of pulp obliteration can further be classified as total obliteration and partial obliteration. In total obliteration the pulp chamber and root canal are hardly or completely not discernible, and partial obliteration, in which the pulp chamber is not discernible and root canal is markedly narrowed but clearly visible.[9]Total pulp obliteration is rare and usually a thin fine residual filament of pulp tissue or tract of organic material is present. Partial obliteration does not have any detrimental effect on the pulp as it involves primarily the pulp chamber. It has more limited effect in the root canal and apical region This might allow the circulatory system of these teeth to react adequately to maintain sufficient blood perfusion.[10] Pulp obliteration can be classified as -localized and generalized.[11] In the localized form, the etiologic agent most often is trauma and this condition has been described relatively frequently after crown and root fractures, tooth luxation, jaw fractures, tooth replantation, and endodontic procedures

Mechanism

The mechanism underlying the pulp canal obliteration is an enigma. According to Torneck (1990)[12]the deposition of hard tissue is either a result of stimulation of the pre-existing odontoblasts or a result of the loss of their regulatory mechanism containing a maze of small irregular spaces and cul-de-sacs, which extend from the pulp chamber to the apical foramen. Andreasen and Andreasen (1994)[13]described calcific metamorphosis as a response to severe injury to the neurovascular supply to the pulp, which after healing leads to accelerated dentin deposition, and is closely related to the loss and re-establishment of the pulpal neural supply.[14] None of these mechanism have been proved hence further evidence based research is necessary to prove the above mechanism. The odontoblasts at the periphery and the undifferentiated pulp cells produce the osteoid tissue similar to that of dentin along the periphery or with in the pulp. These tissues can eventually fuse with one another, producing a rapid and complete pulp canal obliteration.[15]

Ten Cate (1998)[16] identified this process as the deposition of tertiary or reparative dentin in response to irritation or trauma. Reparative odontoblasts are somehow able to differentiate from dental pulp cells in the absence of any epithelial influence. During the development of the tooth, the undifferentiated ectomesenchymal cell of the dental papilla divides into two daughter cells. One daughter cell is influenced by the epithelial cells and differentiates into an odontoblast, while the second daughter cell that is not exposed to the epithelial influence persists as a subodontoblast cell, which under certain influences differentiates into odontoblast-like cells and deposits dentin-like hard tissue.[17]

Reparative dentin or tertiary dentin is deposited at specific sites in response to injury, and rate of deposition depends on the degree of injury. This result in accelerated hard tissue formation that traps some pulpal cells and gives the histologic appearance of osteodentin with an irregular tubular pattern. Evidence indicates that reparative dentin is produced by newly differentiated cells and incorporates type I and III collagen in its matrix, which exhibits diminished phosphophoryn[16] content. The deposition of fibronectin on predentin provides the mechanism for positioning the cells that then produce a matrix of type I and II collagen that accepts mineral in the absence of phosphoryn content. There is much discussion as to whether the mineralized tissue so formed is truly dentin, because the original odontoblasts express type I collagen and phosphophoryn[17] content.

Clinical findings

Colour: According to the Jacobsen & Kerekes (1977)[9] the crowns 79% of 122 teeth with pulpal obliteration of the tooth showed yellow discoloration .these teeth with pulp obliteration is darker in hue than the adjacent teeth and exhibits a dark yellow color because of a decrease in translucency due to a greater thickness of dentin under the enamel. Some teeth also have a grey discoloration it is not mandatory that all teeth with radiographic signs of pulpal obliteration undergo a color change.[3] It has also been found that more than two-thirds of teeth with pulpal obliteration are asymptomatic.

Pulp sensibility testing: Crown discoloration can be combined with negative responses in obliterated case, when tested using electrical or thermal vitality tests. As PCO becomes more pronounced there is a progressive decrease in the response to thermal and electrical pulp testing. The tooth affected by concussion or subluxation injuries, do not always react to sensibility tests for some time.[18] This lack of a response can be reversible, and it is possible that after some weeks, sensibility tests will show positive results, It has also been reported that teeth with partial pulpal obliteration were more responsive to electric pulp testing than compared to that were totally obliterated .It is generally accepted that the absence of a positive response to the electric pulp test does not automatically imply pulp necrosis.[19]

Radiographic findings:

The radiograph of PCO appears either as partial or total obliteration of the pulp canal space with or without associated per apical pathosis.[14] Complete radiographic obliteration of the pulp space does not necessarily mean the absence of the pulp canal space; in the majority of these cases, a pulp space with pulp tissue is present, but the sensitivity of conventional radiographs is too low to allow their image to be captured.[20]

Histopathology: Studies designed to assess the pulp status of teeth with pulpal obliteration have failed to show any signs of inflammation indicative of a pathological process. Patersson & Mitchell (1965)[20]described pulpal obliteration as a tertiary dentine response to trauma that was highly irregular in pattern and calcification. This is not universally accepted, and pulpal obliteration or calcific metamorphosis has also been characterized as multifocal, dystrophic calcifications usually composed of ill-defined secondary dentine.[21]In a study of conducted by Robertson (1996)[22]in traumatized primary teeth it was found that the tissues occluding the pulpal lumen were dentine-like, bone-like or fibrotic in nature know whether the obliteration process seen in primary incisors is similar to that seen in the permanent successors.[22]

Management of calcified canals:

Treatment of calcified canal is delayed until there were symptoms or radiographic signs of per apical disease are clearly evident.[23] Teeth demonstrating pulpal obliteration but no periapical disease should be managed conservatively through clinical observation

and periodic radiographic examination. In the tooth with calcified canals Oginni et al. (2009) [19]recommended that root canal treatment should be initiated in teeth with tenderness to percussion. Teeth with periapical index scores more than or equal to 3 are included for root canal treatment.[19]

Before the access preparation the practioner should assess the distance from the occlusal surface to the pulp chamber by placing the bur on preoperative periradicular film. After the initial access opening, the bur is left in place and three radiographs are taken by applying the buccal object rule to aid in the determination of calcified root canals as follows: [24]

1. Straight – on to the bucco- lingual dimension to determine the position of the head of the bur in the root canal in the mesio-distal dimension
2. Radiograph taken with a 20^0 horizontal angulation with the cone shifted distally.
3. Radiograph taken with a 20^0 horizontal angulation with the cone directed mesially.

Use rubber dam is mandatory. Surgical operating microscope is recommended for, magnification and improved visualization. Adequate lighting and magnification removes all the guess work[25] as most of the general dentists could not afford operating microscope in their clinical set up, dental loupes could be an alternative tool. Access must be straight line. Recently EndoGuide® was introduced, to increase visibility and control during endodontic exploration while locating hidden orifices apart from the traditionally used long neck (LN-bur) round bur, extended-shank round burs, such as the Mueller bur, and the Munce Discovery bur. DG-16 explorer ,Dyes such as methylene blue and Transillumination are used to locate of canal orifice.[26]

In Tran's illumination technique the lights in the room and dental unit are turned off, then fiber optic light is used and it is passed through the tooth at the CEJ level, at this point the tooth will appear like a Jack O'Lantern' with Calcified canals appearing as dark dots and not as wide canals. In champagne' test. 5% sodium hypochlorite is placed into the pulp chamber over a calcified canal containing remnants of pulp tissue resulting in a stream of bubbles emerging from the oxygenation of the tissue. This can be seen under the microscope and be used to identify the canal orifice.[25]

Recently ultrasonic tips with finer tips are preferred over bur to remove less dentin with minimum perforation risk. BUC 1 tip is used for uncovering the pulp chamber floor and in removal of pulp stones. The BUC-3 is a sharp diamond-coated pear tip used to create a smooth, clean flat troughing groove that facilitates canal location under water port for increased washing and cooling of the operative site. Start-X is a set of 5 ultrasonic tips, in which tip #3 is a canal opening scouter and helps in removing any obstruction in the pulp chamber and tip #5 reveals the original pulp chamber floor anatomy .Micro-Orifice Opener aid in initial penetration and locating canals. [27]

Initially hand K files such as #6, #8 and #10 are used for negotiation and estimating the working length of severely calcified canals. These files aid in determining the minor constriction of the root canal. They are made more effective either by precurving with an Endo Bender pliers or trimming the instruments by scissors so that the intentional pressure on the instrument is increased on the point where the files are placed in the canal.[28] The hand K file is attached to an electronic apex locator after the determination of true working length.[29]

Canal Pathfinder which has reduced flute or instruments with greater shaft strength such as the Pathfinder CS (Kerr Manufacturing Co.), can also be used which are more likely to penetrate highly calcified canals. C+ Files (Denstply, Tulsa, OK, USA) are also ideal for initial instrumentation of calcified root canals. They have a cutting tip that engages the dentin. Use of nickel titanium files is contraindicated because of lack of torsional strength. [28]

Recently after the true working length is determined M4 Safety reciprocation Hand piece is used as a valuable tool in increasing the diameter of a severely calcified canal progressively from a #6 hand K file diameter, #8 hand K file to that of a #10 hand K file . The attached file in the M4 safety hand piece rotates in a reciprocation i.e. 30-degree clockwise and 30-degree counter clockwise motion (not a full rotation).M4 hand piece is used with any electric motor at 900 rpm at the torque control of the 18-1 setting. The hand K file should be attached to the M4 hand piece only after it reaches the minor constriction. After each reciprocation use of the file for 15-30 seconds, the canal is irrigated and the canal recapitulated. Reciprocation with M4 hand piece aids in saving time, and hand fatigue. After the canal is enlarged to the size of a #15 hand K file rest of the preparation can be done with a rotary nickel titanium file (RNT).[29] Creating coronal flare with an orifice shaper is a great way to gain further access into a calcified system.

Chelating agents containing ethylene-diamine-tetra-aciticacid (EDTA) are used for lubrication, emulsification, and holding debris in suspension. RC Prep (viscous chelator) is unloaded on to the pulp chamber using a syringe, then precurved files are gently inserted into the root canal. The lubricant encourages the file to slip and *slide* by intracanal calcifications, such as pulp stones or sheaths of fibrotic tissue thus facilitates the negotiation of the canal.[30] After creating clean, tapered canals, clinicians need to adequately obturate the root canal system, provide an impermeable fluid tight seal within the entire root canal system, and prevent coronal and apical micro leakage.

SURGICAL CONSIDERATIONS:

Surgical treatment approach should be considered only in cases where the canal cannot be located and where nonsurgical treatment or retreatment has resulted in a persistence of periapical disease and/or symptoms.[31] Canal identification may also be problematic in the calcified canal after root resection. Dyes such as methylene blue may be used to identify pulp tissue and the root outline. The root-end preparation should be parallel to and coincident with the anatomical outline of the root canal space.[32] The guiding influence of a canal space will be nonexistent in the calcified and previously unprepared canal system. It is likely therefore that this will be a further complicating factor in carrying out surgery on a calcified canal system where there has been no attempt at orthograde root filling. Amir et al. (2001)[14] suggested that once a root-end resection was performed on a calcified canal system, many of the pockets of necrotic tissue, which have been trapped in the calcification process, may be opened to the periradicular tissues, resulting in persistent chronic inflammation and inevitable failure

Conclusion: Calcified canals can be managed of efficiently by their patient and diligent sequential negotiation. Sequential use of the recent armamentarium under adequate illumination and magnification aids in treating calcified canals which had been a night mare to the dentists.

Author affiliation: 1. Dr. Nandamuri Sridevi, MDS, Reader, 2. Dr. Shankarappa Pushpa, MDS, Professor, 3. Dr. Mohammed Iqbal, MDS, Senior lecturer, 4. Dr. Anushree Prasad, Post Graduate, 5. Dr. Prachi Singh, Post Graduate, 6. Dr. Richa Singh, Post Graduate, Dept of Conservative Dentistry and Endodontics, Rama Dental College Hospital and Research Centre.

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Corresponding Author:
Dr. Nandamuri Sridevi,
Reader, Department Of Conservative Dentistry
And Endodontics,
Rama dental college Hospital and Research Centre,
Kanpur, U.P, India.
Contact no: 07571898857
Email id- Nandamuri_Sridevi@Yahoo.In

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