Kallirroi Chaini and Maria K. Georgopoulou

General pulp calcification: Literature review and case report

Kallirroi Chaini, DDS
Department of Endodontics, Dental School, University of Athens, Athens, Greece

Maria K. Georgopoulou, PhD
Assistant professor, Department of Endodontics, Dental School, University of Athens, Athens, Greece

Correspondence to:
Kallirroi Chaini,
Department of Endodontics, Dental School, University of Athens, Athens, Greece.
Tel: +30 6943937679
Fax: +30 27610 24046
Email:chainikallirroi@hotmail.com

Key words *dental pulp, general pulp calcification, pulp stone*

Pulp stones are calcified bodies in the dental pulp of the teeth in the primary and permanent dentition. They are found in healthy, diseased and even unerupted or impacted teeth. This case report presents the diagnostic management of a 22-year old female patient with general pulp calcification that coexists with molar incisor hypomineralisation and compound odontoma. The diagnostic procedure revealed several conditions that could be implicated: possible metabolic imbalance, bruxism, orthodontic treatment and genetic predisposition. Blood tests and urine analysis results excluded the possibility of metabolic imbalance. Clinical examination excluded bruxism and orthodontic treatment as implicated factors. The patient's family dental history revealed that the patient's mother also presents general pulp calcification. The aim of this article is to describe the diagnostic management of the patient and to highlight that general pulp calcification is not such a common finding; clinicians should be suspicious and investigate the possible metabolic imbalance, dysfunction or other correlated systematic diseases which may contribute to their early diagnosis.

Introduction

Pulp stones are calcified bodies in the dental pulps of the teeth in the primary and permanent dentition[1-3].They are found in healthy, diseased and even unerupted or impacted teeth[3-8]. Their calcium / phosphorous ratios are similar to dentin[9].

Pulpal pain of idiopathic nature was considered as one of the frequent symptoms associated with pulp stones[10]. Modern knowledge of mechanisms of nociceptor activation coupled with the observation that pulp stones are frequently observed in teeth lacking a history of pain have largely discounted this hypothesis. Therefore, from a clinical perspective, it would be unlikely that a patient's unexplained pain symptoms are due to pulpal calcifications, no matter how dramatic they may appear on a radiograph[11].

Classification of pulp stones based on location

Pulp stones are reported to occur more often in the coronal region, but are also found in the radicular pulp[3-6,10,12]. Calcification can occur in the dental pulp as discrete calcified stones or in the diffuse form that occur freely in the pulp tissue or embedded into or attached to dentin[8]. Embedded stones are formed in the pulp but, with ongoing physiological dentine formation, they become enclosed (sometimes fully) within the root canal walls. Adherent pulp stones are simply less attached to dentine than embedded pulp stones; the difference between adherent and embedded can be subjective, but the adherent stones are never fully enclosed by dentine. They can also become dislodged. Free pulp stones are found properly within the pulp tissue and are the most commonly radiographically diagnosed type of pulp stones[1,12].

Classification based on histological criteria

Depending on their microscopic structure, pulp stones have been classified into true or false[8]. A third type of "diffuse" or "amorphous" pulp stone is more irregular in shape than false pulp stones, occurring in close association with blood vessels. True pulp stones are made of dentine and lined by odontoblasts, whereas false pulp stones are formed from degenerating cells of the pulp that mineralise. Such mineralisation occurs in stages: initially cell nests become enclosed by concentrically arranged fibres which then become impregnated with mineral salts. Calcified increments are then added[3,9,10,12,13]. Stones can be further subdivided into those with distinct concentric laminations and those without distinct lamination. Laminated pulp stones are not usually associated with smaller stones, whereas non-laminated stones are rougher and may have smaller stones attached to their surfaces[10].

Formation of pulp stones

The formation of pulp stones is still something of an enigma. Studies show that a high frequency of cell islands considered to be of epithelial origin, were observed together with pulp stone formation in teeth that had been suggested for experimental intrusion[10,12]. A study of Bernick[14] demonstrated that calcification also involved the nerve tissue, apart from blood vessels. Initially, discrete isolated regions of calcification occur in the endoneurium and/or the perineurium. The calcifying process, however, soon becomes circumferential, forming a calcified ring around the nerve. The nerve fibre and its fasciculae then impregnate, resulting in nerve obliteration. The collagen bundles of vascular and neural sheaths of old pulps were the loci of calcification. As a result of their calcification, their numbers decrease. The persistence of the connective tissue sheaths of nerves and blood vessels gives the pulp a histologically fibrotic appearance[15].

Implicated factors

The aetiological factors for pulp stone formation are not well understood. However, many factors have been implicated in stone formation[16]. They include:

- Age[1-6,9,10,16-18]. Pulp stones are not considered a physiological development related to age[7,12]. In half the teeth of young people and in almost all the teeth of patients older than 50 years of age, pulp stones are probably visible microscopically[8]. Patients 15 to 75 years old show a decrease in the size of the pulp chamber due to deposition of secondary dentine with increasing age, but also a progressive deposition of calcified masses that originated in the root pulp[10].
- Pulp degeneration[6,8, 6,18]
- Inductive interactions between epithelium and pulp tissue[1,6,8,11,16,18]
- Circulatory disturbances in the pulp[1,3,6,8,9,16,18]
- Idiopathic factors[1,3,4,6,8,9,10,12,16,18,19]
- Genetic predisposition[1-4,6,9,12,16,18]
- Long-standing irritants (caries, deep filings, chronic inflammation and abrasion)[1,3,4,6,8,10,12,17,18]: the pathological effect of irritation by the microorganisms of dental caries on the pulpal tissue can cause a vascular wall injury, resulting in the deposition of calcium salts within the tissue[12].
- Orthodontic tooth movement[1-4,6,8-12,16-18]
- Traumatic occlusion[10,16]
- Trauma[2,9]
- Periodontal disease[4,6,12,16]
- Operative procedures[4,6,12]
- Low-intensity stimuli[16]
- Epithelial rests in the pulp tissue[4,6,16]
- Dental abnormalities as dilaceration, impaction, enamel pearls[5,10], internal resorption, talon cusp, dens invaginatus[5], taurodontism[3], dentin dysplasia type II[1,9,10] and dentinogenesis imperfecta[1,9].
- Drugs[20-23]
- Transplantation[2,9]
- Anaemic personalities[10]
- Metabolic imbalance or dysfunction[10]
- Arteriosclerosis[10]
- Osteitis deformance[10]
- Acromegaly[10]
- Marfan syndrome[8]
- Fluoride supplementation[8]
- Nanobacteria and nanoparticles (CNPs)[24].

For many medical conditions, such as metabolic disorders, cardiovascular disease, kidney stones, gall stones and salivary gland stones, a high prevalence of pulp stones has been reported, so the routine dental radiographs may be useful as a rapid screening method for early identification of these situations[25-29].

Generalised pulp stones are found in the dentitions of individuals with various conditions, namely[10]:

- Tumoral calcinosis[10]
- Dentin dysplasia type II[1,9,10]
- Saethre-Chotzen syndrome[10]
- Elfin facies syndrome[10]
- Familial expansileosteolysis[10]
- Ehlers-Danlos syndrome type I[10]
- Osteogenesis imperfecta type I[10]
- Otodental syndrome[10]
- Cardiovascular disease[10].

CNPs first appeared as self-propagating calcifying macromolecular complexes found in bovine and human blood and blood products. These nanoparticles could produce biogenic carbonate apatite on their cell envelope at all growth phases, which resulted in white biofilm and mineral aggregates closely resembling those found in tissue calcification in the human body. CNPs are capable of producing nucleate hydroxyapatite; thus they have been heralded as one potential aetiological factor of pathological calcification, such as kidney stones or a kidney cyst, gall stones, atherosclerosis and dental calculus in periodontitis. It could be hypothesised that CNPs are involved in the calcification of the dental pulp tissue[24].

Prevalence

The prevalence of pulp stones varies from 8% to 90%, depending on the study type, design and radiographic technique employed. The prevalence is likely to be higher because pulp stones with a diameter smaller than 200µm cannot be seen on radiographs. The histological method of evaluation is reported to yield higher values than the radiographic method[6,9,10,12].

The size of pulp stones may range from microscopic to large masses that obliterate almost the entire pulp chamber[3-5,10,17]. A single tooth may have 1 to 12 or even more stones[6,10,12]. In terms of shape, there are two types of stones: those that are round or ovoid, with smooth surfaces and concentric laminations; and those that assume no particular shape, lack laminations and have rough surfaces[10].

The tooth most commonly affected is the first molar on both arches, followed by the second molar, with the least common being the incisors and canines[7,10]. Many studies report that their prevalence is significantly greater in women, while others have not found statistically significant differences between male and female patients[7].

Clinical importance of pulp stones

The presence of pulp stones can jeopardise the outcome of root canal treatment. These stones often narrow or even obstruct the access to the apical part of the root canal. In the absence of any additional signs or symptoms, pulp stones should not be interpreted as a disorder requiring root canal therapy. Their large size in the pulp chamber may hinder access to canal orifices and alter the internal anatomy. Attached stones may deflect or engage the tip of exploring instruments, preventing their easy passage down the canal. A large pulp stone can be dissected out of the access cavity using burs, and special ultrasonic tips, couples with the dissolving action of sodium hypochlorite. If a stone is attached to the canal wall and a file can be passed alongside the stone, it may be removed by careful instrumentation[10].

Case presentation

A 22-year-old female patient was referred to a private practice, because of crown fracture of tooth 46. Her medical history revealed bone fractures of both forearms in preschool age which made an impression, given that children's bones are soft and usually do not crack with a simple fall. Furthermore, the patient was diagnosed with idiopathic scoliosis at the age of 6, and received conservative treatment with an orthopaedic brace. She also referred daily myoskeletal pain on the neck, upper ends and the spinal cord, which have also led to temporary paralysis of her hands since the beginning of adolescence. When she was 19, the patient broke the third

Fig 1 Clinical photos of the case. Notice the molar incisor hypomineralisation (MIH) with white marks on teeth 11 and 21 (c) and the yellow-brown marks on teeth 16 and 26 (a, b, d and e).

thoracic vertebra due to a fall and was hospitalised. Her general symptoms included passing out, fatigue, general weakness and often muscular cramps. Her situation was investigated with repeated blood tests which showed normal levels of all values, including magnesium.

The patient was examined by orthopaedists, neurologists and a rheumatologist, who suggested exercise, physiotherapy, and even surgical removal of part of the rib to relieve pressure on the cervical plexus. Rheumatic disease was also suspected, but tests did not reveal rheumatic antibodies. It was suggested that tests should be repeated at the age of 25. Unfortunately, it was not possible to come up with a conclusive diagnosis, therefore only symptomatic therapy with paracetamol intake for pain control was suggested. The usual dosage was 1.5 g of paracetamol on a daily basis for at least 4 years.

The patent's dental history included facial pain, with a feeling of tension and pressure, pain and clicking from temporomandibular joint dysfunction (TMJ), bruxism treated with intraoral splint and orthodontic therapy (2001 to 2006) for spacing.

Clinical examination revealed molar incisor hypomineralisation (MIH) with white marks on incisors and yellow-brown marks on molars, enamel fractures and carious lesions on the mesial and distal surfaces of molars and premolars. Tooth 36 was restored with a composite filling and preventive composite restorations (PRR) were performed on teeth 16, 27, 37, 36, 46 and 47.The gingiva and mucosa appeared to be normal (Fig 1).

Radiographic examination revealed pulp stones in the whole dentition, even in maxillary third molars that were out of the occlusal plane. More specifically, in incisors, pulp stones possessed the pulp chamber and extended to the radicular pulp. A radiopaque area adjacent to the root tip of tooth 33 was detected and diagnosed as compound odontoma in the Department of Oral Diagnosis and Radiology of the School of Dentistry, National and Kapodistrian University of Athens, Athens, Greece. Only yearly radiographic follow up without further treatment was suggested (Fig 2). In maxillary and mandibular first and second molars, pulp stones overtook the whole pulp chamber and extended to the radicular pulp. In premolars they were ovoid, and in the first premolars they tended to extend to radicular pulp (Fig 3). More than one pulp stone could be detected.

Due to the combination of pulp stones and compromised medical history, the patient was referred to an endocrinologist for evaluation of her calcium metabolism. Her blood test results showed:

- Calcium: 9.6 mg/dl
- Magnesium: 1.8 mg/dl
- Phosphorus: 3.7 mg/dl
- D-3 vitamin (1, 25-OH): 35 pg/ml
- PTH: 23.7 pg/ml

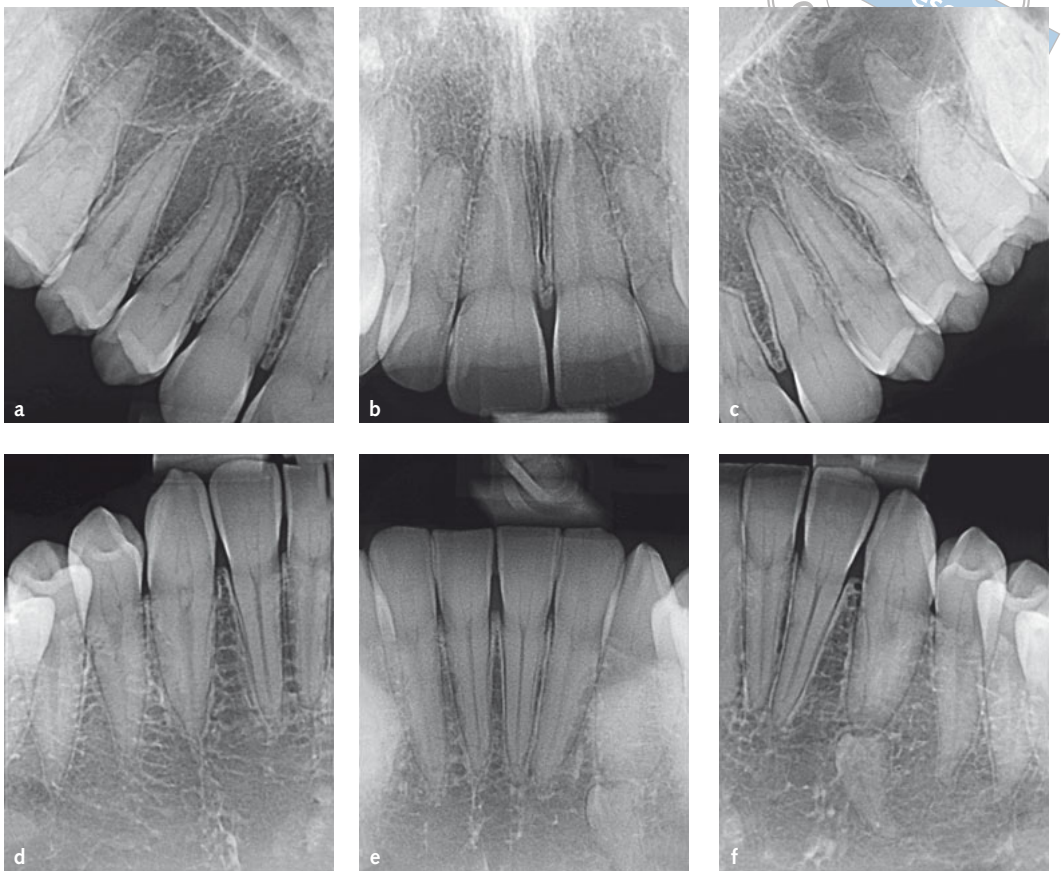

Fig 2 Anterior periapical radiographs that revealed general pulp calcification (a to f). A compound odontoma adjacent to the root tip of tooth 33 was also found (e).

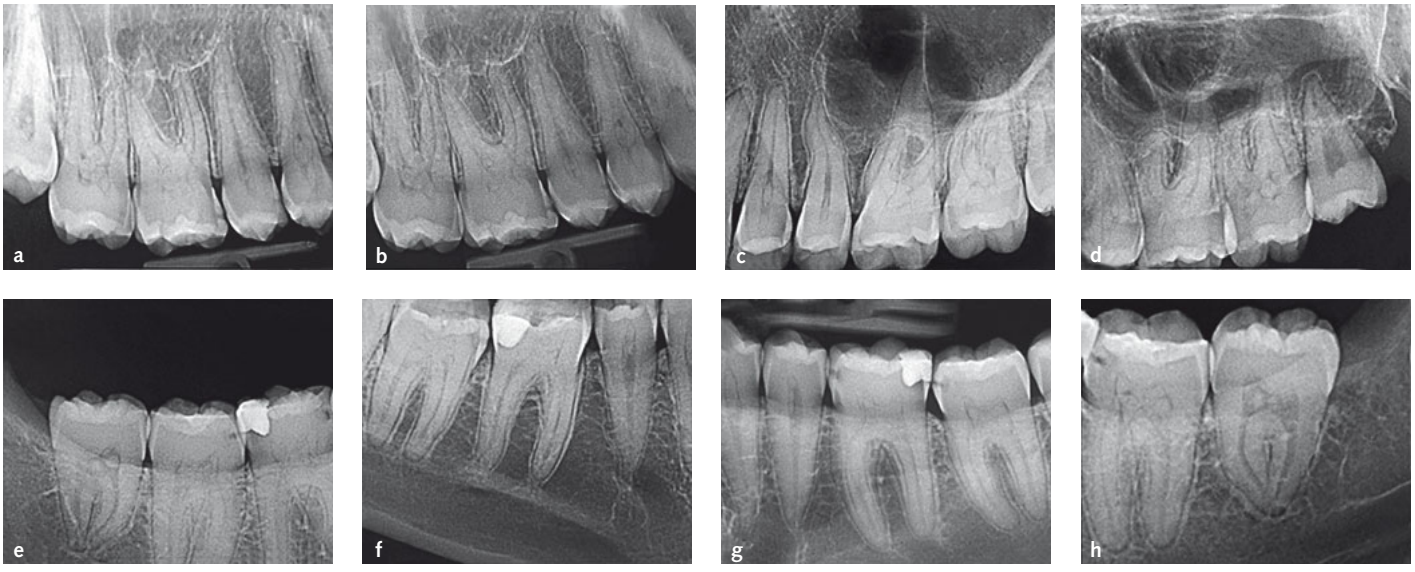

Fig 3 Posterior periapical radiographs that revealed general pulp calcification (a to h).

All these values were within normal limits. Her urine analysis results showed:

- 24h urine volume: 1500 ml
- Calcium (Ca) at 24h: 113 mg/24h

No calcium diet:	5 to 40 mg /24h
Low calcium diet:	50 to 150 mg /24h
Regular calcium diet:	100 to 300 mg /24h

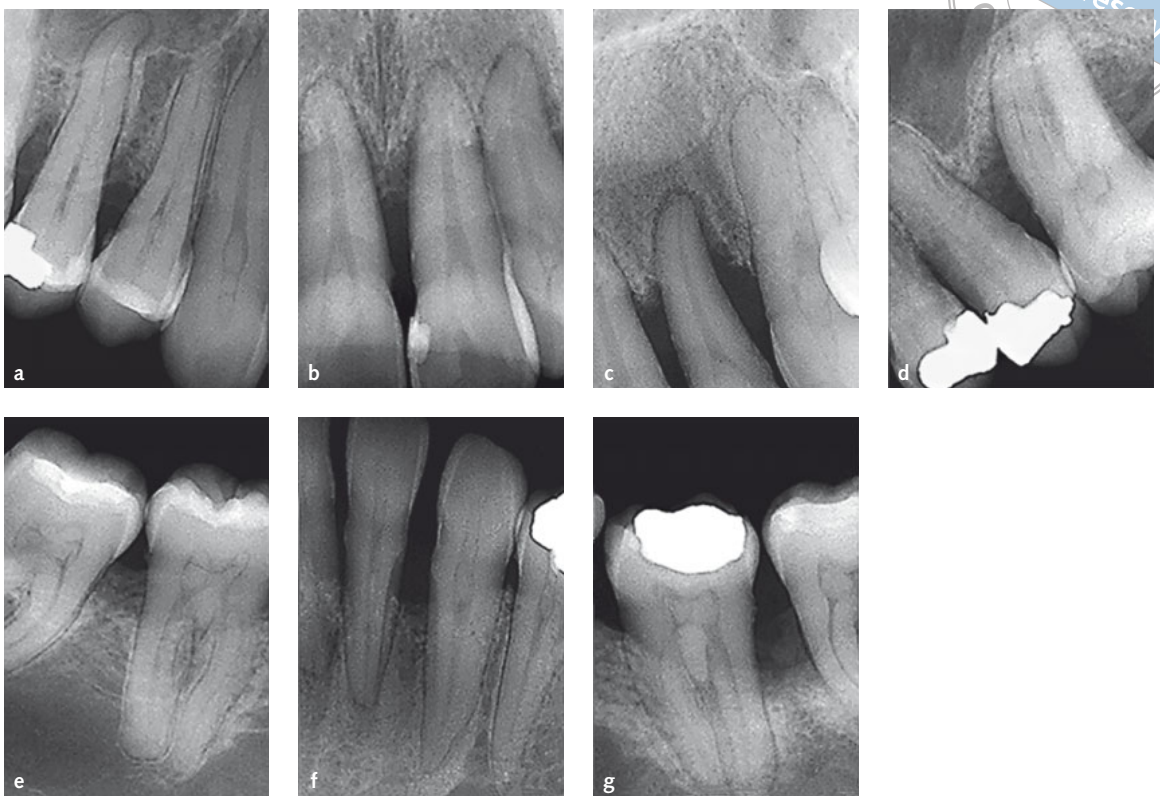

Fig 4 Full-mouth radiographs of the patient's mother, showing the generalised pulp calcification and the periodontal disease (a to g).

Discussion

Generalised pulp calcification in young patients is not a common finding; clinicians should be suspicious and investigate the possible metabolic imbalance, dysfunction[10] or other systematic diseases[10] that may have correlated and contribute to their early diagnosis.

In the present case, the generalised pulp stones were found in a young patient, which is contrary to the general concept of pulp stone formation usually seen in the older age group. Due to her medical history which included a variety of skeletal problems, metabolic disorders were suspected. However, metabolic evaluation of the patient through blood and urine tests and other blood investigations did not reveal any disorder.

The patient's bruxism might be considered as an implicated factor[10]. However, pulp stones were present in third molars, which were out of the occlusal plane, and thus not affected by bruxism. Another consideration was the orthodontic therapy[1-4,6,8-10,12,16-18] that the patient had undergone in childhood. This explanation failed as well, because the treatment was limited to the anterior maxillary teeth. The influence of long-term paracetamol intake was also taken into consideration, but to our knowledge no correlation is established between pulp calcification and paracetamol. Finally, a radiographic examination of the dentition of the patient's family was decided, in order to investigate whether the condition correlated with genetic predisposition[1-4,6,9,12,16,18]. Full-mouth radiographs of the mother also revealed general pulp calcification. Nevertheless, it should be stressed that she suffers from generalised chronic periodontitis (Fig 4)[4,6,12,17], which is a well-established implicated factor. Unfortunately, older radiographs, which might clarify the implication of the periodontal disease, were not available.

To sum up, after thorough assessment, all possible implicated factors, namely metabolic disorder, bruxism, orthodontic therapy and paracetamol intake, were rejected. Genetic predisposition may be possible but without strong evidence. Therefore, the final diagnosis is generalised pulp calcification of idiopathic origin.

References

1. Al-Ghurabi ZH, Najm AA. Prevalence of pulp stone (Orthopantomographic-based). J Bagh Coll Dentistr 2012;24:80–84.
2. Colak H, Celebi AA, Hamidi MM, Bayraktar Y, Colak T, Uzgur R. Assessment of the prevalence of pulp stones in a sample of Turkish Central Anatolian population. ScientificWorldJournal 2012;2012:804278.
3. Sisman Y, Aktan AM, Tarm-Ertas E, Ciftci ME, Sekerci AE. The prevalence of pulp stones in a Turkish population. A radiographic survey. Med Oral Patol Oral Cir Bucal 2012;17:e212–e217.
4. Gulsahi A, Cebeci AI, Özden S. A radiographic assessment of the prevalence of pulp stones in a group of Turkish dental patients. Int Endod J 2009;42:735–739.
5. al-Hadi Hamasha A, Darwazeh A. Prevalence of pulp stones in Jordanian adults. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;86:730–732.
6. Talla HV, Kommineni NK, Yalamanceli S, Avula JS, Chillakuru D. A study on pulp stones in a group of the population in Andhra Pradesh, India: An institutional study. J Conserv Dent 2014;17:111–114.
7. Şener S, Cobankara FK, Akgünlü F. Calcifications of the pulp chamber: prevalence and implicated factors. Clin Oral Investig 2009;13:209–215.
8. Bains SK, Bhatia A, Singh HP, Biswal SS, Kanth S, Nalla S. Prevalence of coronal pulp stones and its relation with systemic disorders in northern Indian central punjabi population. ISRN Dent 2014;2014:617590.
9. Kannan S, Kannepady SK, Muthu K, Jeevan MB, Thapasum A. Radiographic assessment of the prevalence of pulp stones in Malaysians. J Endod 2015;41:333–337.
10. Goga R, Chandler NP, Oginni AO. Pulp stones: a review. Int Endod J 2008;41:457–468.
11. Cohen S. Pathways of the pulp, ed 11. Hargreaves KM, Berman LH, Rotstein I (Eds). St. Louis: Mosby, 2016:566.
12. Turkal, M, Tan E, Uzgur R, Hamidi M, Colak H, Uzgur Z. Incidence and distribution of pulp stones found in radiographic dental examination of adult Turkish dental patients. Ann Med Health Sci Res 2013;3:572–576.
13. Al-Nazhan S, Al-Shamrani S. Prevalence of pulp stones in Saudi adults. Alex Dent J 1991;16:129–142.
14. Bernick S. Effect of aging on the nerve supply to human teeth. J Dent Res 1967;46:694–699.
15. Bernick S, Nedelman C. Effect of aging on the human pulp. J Endod 1975;1:88–94.
16. Ranjitkar S, Taylor JA, Townsend GC. A radiographic assessment of the prevalence of pulp stones in Australians. Aust Dent J 2002;47:36–40.
17. Rodrigues V, Scamardi I, Schacht Junior CF, et al. Prevalence of pulp stones in cone beam computed tomography. Dental Press Endod 2014;4:57–62.
18. Satheeshkumar PS, Mohan MP, Saji S, Sadanandan S, George G. Idiopathic dental pulp calcifications in a tertiary care setting in South India. J Conserv Dent 2013;16:50–55.
19. Siskos GJ, Georgopoulou M. Unusual case of general pulp calcification (pulp stones) in a young Greek girl. Endod Dent Traumatol 1990;6:282–284.
20. Symons AL, Symons DJ. Pulpal obliteration related to long-term glycocorticosteroid medication. Spec Care Dentist 1994;14:103–107.
21. Teixeira D, Freitas MA, Bueno RD, Guimaraes A. Effects of hydrocortisone in the mineralization speed of the dentine. Aust Dent J 1977;22:14–16.
22. Ashwini P, Meena N, Santhos R, et al. Effects of long-term corticosteroids on dental pulp. World J Dent 2010;1:17–20.
23. Pettiette MT, Zhong S, Moretti AJ, Khan AA. Potential correlation between statins and pulp chamber calcification. J Endod 2013;39:1119–1123.
24. Zeng J, Yang F, Zhang W, Gong Q, Du Y, Ling J. Association between dental pulp stones and calcifying nanoparticles. Int J Nanomedicine 2011;6:109–118.
25. Maranhao de Moura AA, de Paiva JG. Pulpal calcifications in patients with coronary atherosclerosis. Endod Dent Traumatol 1987;3:307–309.
26. Kaswan S, Patil S, Maheshwari S, Rahman F, Khandelwal S. The relationship between pulp calcifications and salivary gland calcifications. J Clin Exp Dent 2014;6:e474–e478.
27. Aleksova P, Serafimoski V, Popovska M, Ristovski M. Pulp stones can help in detection of calculus in the kidneys and/or in the bile - fact or fiction? Pril (Makedon Akad Nauk Umet Odd Med Naukl) 2013;34:159–167.
28. Khojastepour L, Pegah B, Khosropanah S, Rahimi E. Can dental pulp calcification predict the risk of ischemic cardiovascular disease? J Dent (Tehran) 2013;10:456–460.
29. Himelhoch DA, Mostofi R. Oral abnormalities in the Ellis-van Creveld syndrome: case report. Pediatr Dent 1988;10:309–313.