Community Dental Health (2011) **28,** 305–307
Received 5 January 2010; Accepted 12 June 2010
© BASCD 2011
doi:10.1922/CDH_ 2633Ardakani03

Association of pulp stones with coronary artery stenosis

F. Ezoddini-Ardakani[1], S.M. Namayandeh[2], S.M. Sadr-Bafghi[2], F. Fatehi[3,4], Z. Mohammadi[1], S. Shahrabi-Farahani[1], A.S. Hedayati[1] and M.J. Rahmani-Baghemalek[1]

[1]School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, Iran; [2]Yazd Cardiovascular Research Center, Shahid Sadoughi University of Medical Science, Yazd, Iran; [3]Department for Research Administration, Shahid Sadoughi University of Medical Sciences, Yazd, Iran; [4]Yazd Diabetes Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

Background: Dental pulp stones are discrete calcifications in the pulp chamber which are often seen in deciduous and permanent teeth. It has been hypothesised that atherosclerosis can be associated with their development. ***Objective:*** To determine whether a higher prevalence of dental pulp stones is correlated with coronary artery stenosis. ***Clinical setting:*** Sixty-one patients aged 20-55 years referred to Afshar Heart Center for invasive coronary angiography were invited to undergo panoramic dental radiography. The panoramic radiographs were independently examined for the presence of pulp stones. ***Results:*** Pulp stones were present in 82% (31/38) of patients with at least one clinically significant coronary artery stenosis and in 48% (11/23) of patients with normal coronary angiography. They were present in 13% of the teeth in the former group and in 5% of the teeth in the latter. The findings show a statistically significant association between coronary artery stenosis and presence of pulp stones (odds ratio 4.83, 95% confidence interval 1.5-15.4). ***Conclusion:*** Coronary artery stenosis and dental pulp calcification are significantly associated. Dental radiography has the potential to be used as a rapid screening method for the early detection of coronary artery stenosis.

Key words*: dental pulp calcification, coronary stenosis, panoramic radiography*

Introduction

Pulp stones are discrete calcifications in the pulp chamber that may develop in both deciduous and permanent teeth. They are usually found free within the dental pulp. The stones may be microscopic or macroscopic, and the latter form can be seen in dental radiographs. Their prevalence has been reported widely ranging from 8% to 95% by various studies in different locations and settings (Arys *et al.* 1993; Moss-Salentijn and Hendricks-Klyvert, 1988; Tamse *et al.,* 1982).

Various aetiologies have been suggested for pulp stones, including dental and systemic diseases, long-term irritation and bacteria (Zeng *et al.,* 2006). It has been suggested that hypercalcaemia is a predisposing factor to pulp stone (Sayegh and Reed, 1968). Although ageing has been shown to contribute to pulp stone development (Bernick and Nedelman 1975; Morse 1991), it has also been suggested that there is no association between ageing *per se* and pulp stone formation (Nitzan *et al.,* 1986).

There is an association between periodontal disease and cardiovascular events whereby periodontal infection can affect systemic vascular disease such as atherosclerosis via inflammatory mediators (Beck *et al.,* 1996; Beck *et al.,* 1999). It has been proposed that the pathogenesis of pulp stones is similar to that of calcified atheromas in cardiovascular diseases (Edds *et al.,* 2005). A higher incidence of pulp calcification has been reported in radiographic studies of patients with coronary atherosclerosis (Maranhao de Moura and de Paiva, 1987) although some animal studies failed to establish any link between the two (Krell *et al.,* 1994; Oguntebi *et al.,* 1992).

We hypothesised that the incidental finding of pulp stones on dental radiography might correlate with a higher rate of coronary artery stenosis and accordingly undertook this study.

Methods

During a 7-month period from March 2008, patients referred to Afshar Heart Center in Yazd, Iran for conventional catheter-based X-ray coronary angiography (CAG) were invited to participate in this study. All patients conformed to the American College of Cardiology criteria for suspected coronary artery stenosis and were aged 20-55 years with at least 8 permanent teeth present.

Catheterisation of coronary arteries was performed by the Seldinger (1953) approach. Coronary angiographic images were acquired using standard techniques by a GE Advantx Rad/Fluoro Suite (GE Healthcare, Milwaukee, Wisconsin). All angiograms were assessed independently by a single experienced cardiologist to evaluate the stenosis of three main arteries in the heart: the left anterior descending or anterior interventricular (LAD), the circumflex (Cx) and the right coronary artery (RCA). Narrowing of more than 50% in LAD or RCA, or 60% in Cx was recorded as a positive finding (Aksay *et al.,* 2007; Gaudino *et al.,* 2002). The extent of the stenosis was not considered. Angiography results were divided into two groups: i, coronary artery stenosis (CAS group); and ii, normal coronary angiography (NCA group). All angiographies of CAS group were graded as I, II or III on the basis of the number of stenotic main arteries identified.

Correspondence to: F. Ezoddini-Ardakani, Department of Oral and Maxillofacial Radiology, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Daheh Fajr Boulevard, Yazd, Iran 89148-81167. Email: ezoddini@gmail.com

Panoramic dental images were acquired with a Planmeca 2002 EC Proline multitomographic X-ray unit (Planmeca Co., Helsinki, Finland). They were obtained with a constant 12mA, 80kV and 18s exposure through 2.5mm Al filtration. Regular Kodak Lanex (Eastman Kodak Co, Rochester, NY) intensifying screens (15x30 cm cassette) and Kodak T Mat G films (Eastman Kodak Co, Rochester, NY) were used in this study. Films were developed in an automatic film processor (Velopex, Extra-X, Medivance Instruments Ltd, London, UK) with standard solutions as recommended by the manufacturer. The total time of processing was 4 minutes at 27°C. All panoramic radiographs were assessed by a single experienced maxillofacial radiologist unaware of the CAG results. The observer evaluated the images over an X-ray film viewer using a 4.5x magnifier in a room with subdued ambient lighting. Pulp stones seen in each panoramic radiograph were recorded along with the patient's name, tooth type and total number of teeth.

Quantitative variables are presented as mean and standard deviation (sd) and categorical variables are described as counts and percentages. Accuracy parameters are presented with 95% confidence interval. A χ^2 test was used to evaluate the difference of pulp stone distribution over CAG results. The association between the percentage of teeth with pulp stones and the number of stenotic vessels was evaluated using Pearson's correlation coefficient or Fisher's exact test when appropriate. The rate of having CAS when a pulp stone was seen was estimated using odds ratio. The Mantel-Haenszel statistical method was used to control for the possible effects of age or gender. All tests were 2-tailed with differences reported as being statistically significant if $p<0.05$. Analyses were carried out using SPSS v.13 (SPSS, Chicago, IL).

The Research Ethics Committee of Shahid Sadoughi University of Medical Sciences approved the study protocol. The nature of the study was explained to each patient and an informed consent was obtained from everyone who agreed to participate.

Results

A total of 61 patients (32 male, 29 female) were recruited and their average age was 43.1 ± 6.5 (mean ± SD) years. Coronary arteries were reported as normal in 23 (38%) patients (NCA group), but the remaining 38 (61%) patients had various degrees of clinically significant stenosis in their angiograms (CAS group). Coronary angiography revealed 1, 2 or 3 stenotic vessel(s) in 14, 12, and 12 patients, respectively.

On panoramic dental radiography, 42 patients had at least one pulp stone. The frequency of pulp stones was highest (36%) in premolars, followed by molars (34%). Frequency distributions of pulp stones are summarised in Table 1. The Pearson χ^2 test showed a difference in the presence of pulp stones between the CAS and NCA groups (p=0.006) while the Pearson's correlation test confirmed a direct relationship (r=0.316) between having pulp stones and number of stenotic vessels (p=0.013).

Odds ratio analysis disclosed that pulp stones are associated with substantial increase in the rate of coronary stenosis (MH-OR= 4.83, CI95% 1.5–15.4, p<0.005). Gender-adjusted odds ratio using the Mantel-Haenszel method also showed a significant association between the presence of pulp stones and coronary artery stenosis (MH-OR=1.3, CI95% 1.1–1.8, p=0.027). Similar analysis, adjusted for age, estimated a substantial increase in the rate of having CAS when pulp stones are detected (MH-OR=3.58, CI95% 1.09–11.78, p=0.036).

On average, the subjects with positive CAG findings had pulp stones in 13.4% of their teeth, compared to 5.5% in those with negative findings: a significant difference. The association of pulp stones with coronary artery stenosis in male and female subjects is shown in Table 2. The proportion of subjects in each subgroup with pulp stone is presented in Table 3.

Table 1. Frequency of pulp stones in patients with normal or abnormal coronary arteries

Pulp stone	CAS group	NCA group	p value *
Positive	31	11	0.006
Negative	7	12	

* Pearson χ^2 test

Table 2. The association of pulp stones with coronary artery stenosis in age and gender subgroups

		Coronary Angiography		
Subgroup	Pulp stone	CAS n=38	NCA n=23	*p* value*
Male	Positive	16	7	0.681
	Negative	5	4	
Female	Positive	15	4	0.005
	Negative	2	8	
<40 years	Positive	8	8	0.126
	Negative	4	8	
≥40 years	Positive	23	3	0.015
	Negative	3	4	

* Fisher's exact test

Table 3. Frequency distribution of coronary stenosis in subjects with and without pulp stone

Number of stenotic vessels	Pulp Stone		Total
	No (n=19)	Yes (n=42)	
0	12 (52%)	11 (48%)	23
1	3 (21%)	11 (79%)	14
2	1 (8%)	11 (92%)	12
3	3 (25%)	9 (75%)	12

Exact test *p*=0.048

Discussion

It has been speculated that dental pulp calcification may have a similar pathogenesis to calcified vascular atheromas (Edds *et al.,* 2005). Pulp stones are often considered as physiological structures although they can be associated with some specific pathologies like cardiovascular disorders (Goga *et al.,* 2008).

In a study by Hammsha and Darwazeh (1998), no relationship was found between age and the presence of pulp stones. They reported that first and second molars had the highest frequency of pulp stones which they interpreted as a consequence of the larger pulp volume and better blood supply in those teeth compared with the rest of the permanent dentition. They also found that pulp stones were more prevalent in men than women. An association between pulp stones and renal disease has been reported by Nasstrom and colleagues (1985) who found that pulp chamber narrowing was seen more frequently in patients with transplanted kidneys than in other groups. Those authors suggested that high doses of glucocorticoids may be involved in that development.

Pulp stones have been reported in 74% of patients with CAS and in only 39% of patients without coronary artery stenosis (Edds *et al.,* 2005). The present study, in which pulp stones were detected in 82% of patients with CAS, compared with only 48% of patients without CAS, supports those findings. Further, in our study panoramic radiography was used which exposed patients to a smaller dose of radiation compared with the full mouth series of radiographs used by those investigators.

Our findings contrast with those of Sener and colleagues (2009) who found no correlation between presence of CAS and pulp stones. This may be explained by the fact that they considered a wide range of cardiac conditions, from hypercholesterolemia to heart surgery, while we specifically focused on coronary artery stenosis.

Conclusion

The findings show that coronary artery stenosis has a statistically significant association with presence of dental pulp stones. It suggests that dental radiography has the potential to be used as a screening method for the early detection of coronary artery stenosis.

Acknowledgements

The authors have no financial affiliations related to this study or its sponsors. This study was fully funded by Shahid Sadoughi University of Medical Sciences in Yazd, Iran. Special thanks are due to Mr Mohammad-Hossein Ahmadieh for facilitating the statistical analyses.

References

Aksay, E., Karcioglu, O., Yanturali, S. and Kirimli, O. (2007): Angiographic extent of coronary artery stenosis in patients with high and intermediate likelihood of unstable angina according to likelihood classification of American Heart Association. *Anadolu Kardiyoloji Dergisi* **7**, 287-291.

Arys, A., Philippart, C. and Dourov, N. (1993): Microradiography and light microscopy of mineralization in the pulp of undemineralized human primary molars. *Journal of Oral Pathology & Medicine* **22**, 49-53.

Beck, J., Garcia, R., Heiss, G., Vokonas, P.S. and Offenbacher, S. (1996): Periodontal disease and cardiovascular disease. *Journal of Periodontology* **67**, 1123-1137.

Beck, J.D., Pankow, J., Tyroler, H.A. and Offenbacher, S. (1999): Dental infections and atherosclerosis. *American Heart Journal* **138**, S528-S533.

Bernick, S. and Nedelman, C. (1975): Effect of aging on the human pulp. *Journal of Endodontics* **1**, 88-94.

Edds, A.C., Walden, J.E., Scheetz, J.P., Goldsmith, L.J., Drisko, C.L. and Eleazer, P.D. (2005): Pilot study of correlation of pulp stones with cardiovascular disease. *Journal of Endodontics* **31**, 504-506.

Gaudino, M., Alessandrini, F., Nasso, G., Bruno, P., Manzoli, A. and Possati, G. (2002): Severity of coronary artery stenosis at preoperative angiography and midterm mammary graft status. *The Annals of Thoracic Surgery* **74**, 119-121.

Goga, R., Chandler, N.P. and Oginni, A.O. (2008): Pulp stones: a review. *International Endodontic Journal* **41**, 457-468.

Hamasha, A.H. and Darwazeh, A. (1998): Prevalence of pulp stones in Jordanian adults. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* **86**, 730-732.

Krell, K.V., McMurtrey, L.G. and Walton, R.E. (1994): Vasculature of the dental pulp of atherosclerotic monkeys: light and electron microscopic findings. *Journal of Endodontics* **20**, 469-473.

Maranhao de Moura, A.A. and de Paiva, J.G. (1987): Pulpal calcifications in patients with coronary atherosclerosis. *Endodontics & Dental Traumatology* **3**, 307-309.

Morse, D.R. (1991): Age-related changes of the dental pulp complex and their relationship to systemic aging. *Oral Surgery, Oral Medicine, and Oral Pathology* **72**, 721-745.

Moss-Salentijn, L. and Hendricks-Klyvert, M. (1988): Calcified structures in human dental pulps. *Journal of Endodontics* **14**, 184-189.

Nasstrom, K., Forsberg, B., Petersson, A. and Westesson, P.L. (1985): Narrowing of the dental pulp chamber in patients with renal diseases. *Oral Surgery, Oral Medicine, and Oral Pathology* **59**, 242-246.

Nitzan, D.W., Michaeli, Y., Weinreb, M. and Azaz, B. (1986): The effect of aging on tooth morphology: a study on impacted teeth. *Oral Surgery, Oral Medicine, and Oral Pathology* **61**, 54-60.

Oguntebi, B.R., Stafford, D.S., Cerda, J. and Robbins, F. (1992): Vascular changes in the dental pulp in the hypercholesterolemic miniature swine. *Oral Surgery, Oral Medicine, and Oral Pathology* **74**, 351-356.

Sayegh, F.S. and Reed, A.J. (1968): Calcification in the dental pulp. *Oral Surgery, Oral Medicine, and Oral Pathology* **25**, 873-882.

Seldinger, S.I. (1953): Catheter replacement of the needle in percutaneous arteriography; a new technique. *Acta Radiologica* **39**, 368-376.

Sener, S., Cobankara, F.K. and Akgunlu, F. (2009): Calcifications of the pulp chamber: prevalence and implicated factors. *Clinical Oral Investigations* **13**, 209-215.

Tamse, A., Kaffe, I., Littner, M.M. and Shani, R. (1982): Statistical evaluation of radiologic survey of pulp stones. *Journal of Endodontics* **8**, 455-458.

Zeng, J.F., Zhang, W., Jiang, H.W. and Ling, J.Q. (2006): [Isolation, cultivation and initial identification of Nanobacteria from dental pulp stone]. *Chinese Journal of Stomatology* **41**, 498-501.