

# Calcification in the dental pulp

*F. S. Sayegh, D.D.S. and A. J. Reed, D.D.S., Rochester, N. Y.*

EASTMAN DENTAL CENTER

Whether the presence of various forms of calcification within the dental pulp may be considered within the normal range of the biologic variation of the pulp is questionable.

Although the exact cause of pulp calcification is still unknown, available information indicates that the incidence increases with age. It is not established whether or not pulpal diseases, arising from caries or traumatic procedures, are associated with pulp calcification. Microorganisms, as well as various local or systemic diseases, including arteriosclerosis, gout, renal lithiasis, osteitis deformans, hypercementosis, and torus palatinus, are considered as possible factors in pulpal calcification.<sup>1</sup> According to Thoma,<sup>2</sup> formation of pulp stones could be due to hypercalcemia or encapsulation of foreign bodies (dead cells or bacteria).

Hill<sup>3</sup> reported the incidence of pulp calcification to be 66 per cent in persons between the ages of 10 and 20 years and 90 per cent between the ages of 50 and 70 years. He considered pulp calcification, which is perivascular or perineural, to be associated with pyorrheal teeth, hyalinized connective tissue, and fibrosis of the pulp. James<sup>4</sup> found early pulpal calcification in 56 per cent of young patients whose teeth were condemned for orthodontic reasons. Willman<sup>5</sup> reported that 87 per cent of 164 teeth examined at random demonstrated pulp calcification. According to Orban,<sup>6</sup> calcification is frequently found in normal pulp. Boyle,<sup>7</sup> on the other hand, considered it a sign of pulpal degeneration. It appears, then, that calcification may be either a pathologic or a physiologic state of the pulp. This study attempts to survey the frequency of occurrence of pulp calcification in carious and noncarious human teeth at various ages and to describe the histomorphology of these structures.

## MATERIAL AND METHOD

This report is based on a histologic survey of the evidence of calcification in 591 human teeth which were used in previous studies. The teeth included permanent, erupted, single-rooted, multirooted, and some deciduous teeth.

**Table I.** Number of teeth surveyed histologically and breakdown according to sex and age

| Group | Teeth studied | Age range in years |          | Sex  |        |
|-------|---------------|--------------------|----------|------|--------|
|       |               | 6 to 20            | HI to 63 | Male | Female |
| I     | 212           | 212                | 0        | 116  | 96     |
| II    | 181           | 68                 | 113      | 110  | 71     |
| III   | 198           | 103                | 95       | 99   | 99     |
| Total | 59?           | 383                | 208      | 325  | 266    |

**Table II.** Classification of teeth according to structure and location

| Group No. | Calcification | Diffuse type |         | Discrete type |         |      |       | Location |          |
|-----------|---------------|--------------|---------|---------------|---------|------|-------|----------|----------|
|           |               | Foot         | Chamber | Foot          | Chamber | True | False | Free     | Attached |
| I         | 76            | 26           | 0       | 25            | 27      | 35   | 16    | 37       | 4        |
| II        | 54            | 16           | 1       | 11            | 30      | 33   | 8     | 0        | 3        |
| III       | 57            | 8            | 7       | 19            | 33      | 35   | 18    | 0        | 4        |
| Total     | 187           | 50           | 8       | 55            | 90      | 103  | 42    | 37       | 11       |

Table 1 shows the number of teeth surveyed and the breakdown according to sex and age. Groups 1 and II consisted of 393 carious teeth which were pre-selected for removal for surgical and carious reasons. Group III consisted of 198 teeth which were noncarious but condemned for orthodontic or prosthodontic reasons.

Group I represented the carious young-age group, Group II represented the carious mixed-age group (young and old), and Group III represented the noncarious mixed-age group. Since more teeth were studied from the young-age group, the incidence of calcification was calculated for each group separately, and the over-all percentage was calculated.

Table II shows the histomorphologic classification of pulpal calcification as documented in various textbooks.<sup>7, 6, 8, 14, 15</sup> It is true that other authors differ with this classification;<sup>9</sup> however, since the objective of this report is mainly to present the incidence of pulp calcification, regardless of how it appeared or where in the pulp it occurred, we have given the classification and the etiology only minor attention.

Immediately after extraction, the teeth were placed in buffered 10 per cent formalin. After adequate fixation (3 to 5 days), the teeth were decalcified, embedded in Paraplast, and serially sectioned; they were stained with hematoxylin and eosin, and in some cases the Mallory and Masson's connective-tissue stains were used. Each section was studied for evidence of calcification within the pulp and the adjacent dentine. The location, whether coronal or apical, was recorded, and the calcifications were sorted as to whether they were discrete denticles (true or false) or of the diffuse type and also as to whether they were free (entirely surrounded by pulp tissue), attached (partly

2 ..'th dvAxlhi),u±embedded (entirely surrounded by dentin).

**Table III.** Incidence of pulp calcification in the three groups studied

| <i>Group No.</i> | <i>Total</i> | <i>Teeth with calcification</i> | <i>Calcification *<br/>(per cent)</i> |
|------------------|--------------|---------------------------------|---------------------------------------|
| I                | 212          | 76                              | 36                                    |
| II               | 181          | 54                              | 30                                    |
| III              | 198          | 57                              | 29                                    |
| Total            | 591          | 187                             | 32                                    |

\* Rounded figures.

**Table IV.** Incidence of pulp calcification in nonearious teeth

| <i>Age (yr.)</i> | <i>No. of teeth studied</i> | <i>Pulp calcification</i> | <i>Calcification<br/>(per cent)</i> |
|------------------|-----------------------------|---------------------------|-------------------------------------|
| 10-20            | 103                         | 8                         | 8                                   |
| 22-44            | 43                          | 3                         | 7                                   |
| 45-63            | 52                          | 46                        | 90                                  |
| Total            | 198                         | 57                        | 29                                  |

**Table V.** Incidence of pulp calcification in carious and nonearious young teeth (age 10 to 34)

|            | <i>No. of teeth studied</i> | <i>Pulp calcification</i> | <i>Calcified (per cent )</i> |
|------------|-----------------------------|---------------------------|------------------------------|
| Carious    | 212                         | 76                        | 36                           |
| Nonearious | 146                         | 11                        | 8                            |

## RESULTS

### Calcification incidence

Table III reveals the incidence of pulpal calcification in each group. In Group I, which was composed of young carious teeth, it was noted that, of 212 teeth studied histologically, 76 demonstrated some type of calcification; thus, the incidence of calcification was 36 per cent. Similarly, the incidence in Group II, which was composed of 181 young and old carious teeth, was 30 per cent. In Group III, which was composed of 198 nonearious teeth, the calcification incidence was 29 per cent. However, when the nonearious teeth that showed calcification were surveyed (Table IV), it was found that 80 per cent were teeth of older patients in Group III. There was no significant difference in incidence of calcification between the carious and nonearious groups when age was not a factor. However, when incidence of calcification was calculated for young nonearious teeth as compared to young carious teeth (Table V), a significant difference was found: the carious young group showed five times as much pulp calcification as the nonearious group.

### Classification

The classification of the pulp calcifications according to structure and location is shown in Table II. The size of these structures was considered of

limited importance because no relationship could be observed between calcification size and pulp function. In Group I, 26 teeth showed a diffuse type of pulp calcification in the root; 52 teeth demonstrated a discrete type of pulp calcification, 25 in the root and 27 in the pulp chamber; the false type was observed in 16 teeth, and the true type in 35. When the location of these structures in the pulp was considered, only a few were found embedded or attached to the dentinal walls. Some teeth exhibited both the diffuse and the discrete types of calcification.

### Histomorphology

Fig. 1 demonstrates a typical form of the diffuse type of calcification which was observed mainly in the root portion. This form of calcification was observed only infrequently in the pulp chamber.

The predominant form of the discrete type of calcification is seen in Fig. 2. This is what is called the denticle type. Although a close similarity to dentine was observed, dentinal tubules were not evidenced. The amorphous appearance of this structure was observed in various sizes, and these denticles differed in size from one tooth to another. While some of the denticles measured 50 to 100 microns in diameter, others occluded the entire pulpal chamber (Fig. 3).

Fig. 4 demonstrates the so-called false denticle, with concentric layering

*Fig. 2»* Photomicroradiograph representing “true” type of denticle. Note amorphous homogeneous appearance of this structure.

*Fig. 3.* Photomicroradiograph showing denticle which almost occluded entire cavity of dental pulp.

*Fig. 4.* Photomicroradiograph showing “false” type of denticle. Note concentric layering and central nidus of this structure.

*Fig. 5.* Photomicroradiograph showing proximity of denticle to blood vessels in dental pulp.

*Fig. 6A.* Photomicroradiograph showing denticle attached to dentinal wall. Compare this type of attachment with that observed in *Fig. 6B.*

*Fig. 6B.* Photomicroradiograph showing another form of attached denticle. Observe calcified structure which is attached to dentinal wall at two points.

of deposits around a central nidus. Quite frequently, these calcified structures were seen in close proximity to blood vessels or nerve fibers (*Fig. 5*).

Nodules which closely resembled dentinoid structures were observed on rare occasions, but careful serial sections revealed that these were artifacts which formed in diagonally cut sections.

Although most of the nodules (pulp stones) observed were of the free

*Fig. 7.* Section showing calcific degeneration in dental pulp. Observe needlelike, cylinder type of calcified material which appeared parallel to collagen fibers.

type, another form of calcification was observed attached to the dentinal wall. Figs. 6A and 6B show calcifications which were very much associated with dentine; this type was not frequently observed. The other rare type of fibrillar (dystrophic) calcification is demonstrated in Fig. 7.

In a few cases, both true and false denticles were observed in the same tooth. Very infrequently, denticles which almost filled the entire cavity of the pulp were observed. These were seen mainly in the older age group.

## DISCUSSION

From this study, it would appear that the incidence of pulp calcification in the teeth of children and young adults is increased by the irritation of dental caries. As indicated in Table V, the caries-free teeth had significantly less pulpal calcification than their carious counterparts. These figures lend support to the theory that pulp calcification is a physiologic process.

Comparison of pulp calcification in caries-free teeth in various age categories (Table IV) reveals that the incidence is much greater in teeth from older patients (over 45) than in teeth from younger ones. These figures lend support to the theory that pulp calcification is a physiologic process.

The incidence of calcification varies from the 56 per cent in young patients found by James<sup>4</sup> to the 87 per cent in all age categories reported by Willman.<sup>5</sup>

uiui accept me finding of 90 per cent incidence in patients over 45



as an indication that pulp calcification is a normal degenerative process associated with aging, we can theorize that a survey of 80-year-old teeth would reveal an incidence approaching 100 per cent. Most investigators, including Bodecker,<sup>13</sup> have paid little attention to the age factor because pulp stones were found in both young and old patients.

Our observations indicate that it is not necessary for pain to be associated with pulp stones. If pain was experienced by patients with calcific bodies in the pulp it may have been coincidental, since none of the 57 teeth in Group III which demonstrated pulpal calcification gave any symptom of pain. In a tooth with a pulpitis condition, if pulp stones were present during the inflammatory reaction, their presence would probably aggravate the situation. The locations of these calcific bodies were commonly perineural and perivascular, and this may explain their role in the tooth that is experiencing pulpitis. Some workers<sup>11</sup> established the diagnosis of "pulpal neuralgia" in teeth with pain which resembled the pain in acute pulpitis after drug treatment had failed; they claimed that highly and less highly organized denticles were seen in four cases studied. Spicer<sup>12</sup> believed that in most cases pulp stones do not give rise to symptoms, but on occasion may cause obscure symptoms of neuralgia and on other occasions may cause severe pain which occurs suddenly without previous symptoms.

This study did not deal with the etiology of the pulp stones. However, in the light of the routine histologic study of the stained sections, the association of these calcified structures with degenerative tissues cannot be denied. Whether the nidi of such calcifications had originated from calcified thrombi or other vascular changes is beyond the scope of this report, although this hypothesis was considered because of the perivascular and perineural location, in the dental pulp, of these calcified structures. Johnson and Bevelander,<sup>9</sup> who studied the pulpal calcification with histochemical methods, indicated that reticular connective tissue fibers, mucoproteins, and acid polysaccharides were constant findings of the loci which subsequently formed the denticles in the dental pulp.

When considering the classification of these calcified structures, we, as well as Johnson and Bevelander,<sup>9</sup> found the diffuse type predominantly in pulp canals. We have observed these calcified structures both in the pulpal horn and in the chamber; some were free, whereas others were attached or embedded. However, the true or false types were clearly distinct. We believed that what others referred to as true denticles, exhibiting a dentinal tubular pattern, could have resulted from the use of a bias cut during sectioning. A lamellated form of denticle (false) was observed and was clearly distinct from the homogenous type, as shown in Fig. 2 and 3.

## SUMMARY

A total of 591 human teeth were surveyed histologically for pulpal calcification. Both carious and noncarious teeth, taken from patients ranging in age from 8 to 63 years, were included. The incidence of pulpal calcification in carious teeth from children and young adults was nearly five times that in noncarious

teeth from the same age group. A comparison was made between young and old patients with noncarious teeth and the findings revealed that the incidence of pulpal calcification in older patients was ten times that seen in young patients.

The pulp calcifications were classified as diffuse or discrete, and their locations were recorded as root or crown. The discrete calcifications were further classified according to histomorphology.

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