

Effect of Aging On the Nerve Supply To Human Teeth

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Calcification of the pulp, diffuse or nodular, is a common occurrence in old teeth.^{1,3} A recent report⁴ compares the vascular supply of the pulps of young and old teeth. It shows that 90 percent of teeth from individuals more than 40 years of age have some degree of pulpal calcification, mainly involving the apically located blood vessels. Concomitant with the calcification of blood vessels, there is an apparent decrease in the number of demonstrable blood vessels supplying the coronal pulp. Because nerves are associated with the blood vessels in their course throughout the pulp, it becomes of interest to study the effects of aging on the nerves and their termination in the pulps of old teeth.

Materials and Methods

As was indicated in a previous study by Bernick⁴ 150 upper and lower, noncarious, erupted teeth, obtained from males and females 40 to 70 years of age, were used in this study. Extracted teeth were collected from individuals undergoing either periodontal treatment or denture replacement. The specimens were composed from the following age groups:

<i>Age In Years</i>	<i>No. of Specimens</i>
40-49	40
50-59	45
60-69	35
70-	30

In addition, 30 noncarious teeth, removed for orthodontic reasons from individuals less than 20 years of age, were used as controls.

Immediately after extraction, the teeth were fixed in a formal-alcohol-acetic acid solution mixture. They were then decalcified in 10 percent nitric acid in 10 percent for-

malin solution. After decalcification, the specimens were washed in saturated lithium carbonate. Individual teeth were then divided into apical and coronal portions and prepared for nitrocellulose embedding in the routine manner. The apical portions of the teeth were cut in cross sections, and the coronal blocks were sectioned in a sagittal plane. Alternate cut sections, 20 thick, were stained by Verhoeff's iron hematoxylin stain; periodic acid-Schiff (PAS) and hematoxylin, and Pearson's silver gelatin impregnation method.

To differentiate between collagenous elements and nerve fibers, pepsin hydrolysis was used.⁵ After the pepsin hydrolysis, the specimens were prepared for nitrocellulose embedding in the manner described. Thick sections (100 to 200/z) were stained with Verhoeff's iron hematoxylin stain or by Pearson's silver gelatin impregnation method.

Results

Calcification of the pulp occurred in more than 90 percent of all the teeth obtained from individuals more than 40 years old. The pulpal tissue in the apical third of the root was more frequently involved by the calcification process than the coronal portion. During the process of calcification, isolated regions in the endoneurium and perineurium of nerve fibers became mineralized (Fig. 1). With further impregnation, the entire endoneural or perineural connective tissue, or both tissues, became fully mineralized and appeared as a calcified ring around the nerve fibers (Fig. 2). The calcification process was not limited to the connective tissue sheaths of the nerves but extended to involve the nerve proper. This event led to the obliteration of the majority of nerve bundles in the root portion of the pulp (Fig. 3). The effects of advanced calcification of the pulp from an aged tooth can

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FIG. 1 — Section of the pulp in the region of the apical third of the root of a premolar from a 50-year-old individual. There are isolated regions of calcification in the perineurium and endoneurium of nerve fasciculi and individual fibers. B—Blood vessels; *—nerve fasciculus; C—calcifying mass. (Verhoeff's iron hematoxylin stain; orig. mag. X 150).

FIG. 2.—Section of the pulp in the region of the apical third of the root of a canine tooth from a 40-year-old individual. The calcification process has progressed to encircle a small nerve fasciculus. B—Blood vessels; N—nerve fasciculus; G—calcifying mass. (Verhoeff's iron hematoxylin stain; orig. mag. X 150).

Exo. 3.—Section of the pulp in the region of the apical third of the root of a molar tooth from a 60-year-old individual! The calcification process has extended to involve the majority of nerve fasciculi. Only one nerve, fasciculus appears intact. B-Blood vessels; N-nerve fasciculus; C-calcifying mass. (Verhoeff's iron hematoxylin stain; orig. mag. X 170.)

Fio, 4—Section of the pulp in the region of the apical third of the root of a molar tooth from a 60-year-old individual. The calcified mass has obliterated all but one demonstrable nerve fasciculus. B-Blood vessel; C-calcifying mass. (Verhoeff's iron hematoxylin stain; orig. mag. X 50)

tained calcified masses. Another example of the effect of calcification on the peripheral distribution of nerves in the coronal portion of the pulp is illustrated (Fig. 8). In this section, multiple loci of calcification appear to fill the pulpal space. Many of the calcified masses appeared to be associated with nerve fasciculi or individual fibers, or both. Here, also, there was a decrease in demonstrable nerves in the pulpo-odontoblastic zone.

The nerves that persisted in the pulps of old teeth, usually demonstrated characteristics of nerve degeneration such as fragmentation, beading, and reticulation (Fig. 9). Nerve fibers in young teeth appeared as intact tubular fibrils (Fig. 10),

Discussion

One of the most conspicuous changes in teeth observed with advancing age is calcification of the pulp. Hill reports that 90 percent of the pulps from individuals more than 50 years old exhibited calcification. In the present study, the percent of incidence was

FIG. 5.—A thick section of the coronal portion of the pulp from a molar tooth from a teenage individual. The pulpal nerve divides into cuspal nerves, and there is formation of a subodontoblastic network. FN—Pulpal nerve; CN—cuspal nerve; B—blood vessels. (Verhoeff's iron hematoxylin stain; orig. mag. X 30*)

be seen in a section of the pulp (Fig. 4) in which only a single nerve fasciculi of the main pulpal nerve remained free from calcification.

In all the young teeth examined, there was no histologic evidence of pulpal calcification in the root or crown. In thick sections from those teeth (100 to 200 μ), it was observed that the pulpal nerve entered the coronal portion of the pulp and branched into cuspal nerves, which coursed toward the cuspal horns. Before entering the cuspal horns, a subodontoblastic plexus was formed (Fig. 5, 6). In contrast, in the coronal portion of old pulps there was an apparent loss in the number of demonstrable nerve fibers (Fig. 7, 8). A thick sagittal section of the crown portion of an old tooth shows the large pulpal nerve as it enters the crown from the root, which was the only distinct demonstrable nerve (Fig. 7). A few isolated fibers were visible in the subodontoblastic plexuses. In this section, there was no evidence of pulpal calcification; yet, in the root portion of this tooth, the pulp con-

FIG. 6 "A thick section of a coronal portion of the pulp from a premolar from a teenage individual. There is extensive branching of the pulpal nerves and a rich subodontoblastic network. B—blood vessels; PN—pulpal nerve; N—nerve fasciculus (Verhoeff's iron hematoxylin stain; orig. mag. Of"

the endoneurium or perineurium or both, of an individual nerve fiber or fasciculus. The calcifying process soon became circumferential, forming a calcified ring around the nerve. Finally, the nerve fiber and its fasciculi were impregnated, resulting in obliteration of the nerve.

Regardless of whether the coronal pulpal tissue was mineralized, there was an apparent decrease in the number of demonstrable nerves: in the crown pulp of old teeth. The author has reported previously that, in young teeth, the common pulpal nerve consists of multiple fasciculi that pass up the root to enter the coronal pulp. Here, the nerve branches send twigs to the cuspal horns. At the pulpal odontoblastic border, a rich network is formed. From this network, terminal branches arise that enter the odontoblastic zone to terminate among the odontoblasts. A few fibers enter the predentin, form a loop, and then return to end in the odontoblastic layer. In contrast, there was

■Frei 7—A thick section of coronal portion of the pulp from a; molar tooth from a 50-year-old individual. Only the pulpal nerve is demonstrable; the cuspal branches and subodontoblastic network are absent. Although there is no sign of calcification in the crown, the apical portion of the root of this tooth exhibited diffuse calcification of the pulp. PN—Pulpal nerve, B—blood vessels. (Verloef's iron hematoxylin stain; orig. mag. X 50Q-)

similar to Hill's findings as well as others reported in the literature*^{2,3} Pulpal calcification is of two types; that is, pulp nodules (stones) and diffuse calcification. Both types of calcification probably are no more than different morphologic varieties resulting from similar processes. In aging, there is an increase in both mucopolysaccharide and fibrous elements, a situation acceptable for calcification. In the present study, both types of calcification were present in the root and crown portion of the aging tooth. The incidence of pulpal calcification was more frequent in the apical third of the root than the crown. It was not unusual to find diffuse calcification in the root and not in the crown of an individual tooth.

The process of calcification did involve the nerves of the pulp. As the pulpal tissue became calcified, the process soon encroached on the connective tissue sheaths of the nerves. Initially, discrete isolated regions of calcification were demonstrable in

Fig. 8.—A thick section of coronal portion of the pulp from a premolar from a 40-year-old individual. Notice the heavy calcified mass occupying the occlusal portion of the pulp and the loss of demonstrable nerves in the pulp. Compare with Figure 6. The bands of fibers seen in the section are collagen in nature. B—Blood vessels. N—nerve, C—calcifying mass, Co—collagen fibers. (Verhoeff's iron hematoxylin stain; orig. mag. X 50.)

FIG. 9.—Sections of two nerve fibers in the pulps illustrated in Figures 7 and 8. Notice the fragmentation, beading and reticulation of the nerve fiber characteristic of degenerating nerves (Verhoeff's iron hematoxylin stain; orig. mag. X 45CF)

a conspicuous absence of demonstrable nerves in the pulp of old teeth, especially in the pulp-odontoblastic zone and pulpal horn; The pulpal nerves that persisted had typical degenerative features such as reticulation and fragmentation.

The findings of the present study indicate that pulpal calcifications, a feature of aging, influence the nerves supplying the pulp. The apparent loss of nerves in the pulp as a result of calcification might explain, in part, the decrease in "sensitivity" of teeth of individuals more than 40 years of age.

Summary

Noncarious extracted teeth from individuals 40 to 70 years of age were used to study the effect of aging on the nerves supplying the pulp. Noncarious teeth from young individuals, less than 20 years of age, were used as controls. Ninety percent of the pulps of old teeth exhibited pulpal calcification, both diffuse and nodular. In contrast, pulp from none of the young teeth showed evidence of calcification. The process of calcification first involved the connective tissue covering the nerves, and then the nerves themselves. The calcifying process led to the obliteration of the nerves. As a result of the calcification of the nerves located in the apical portion of the root, there was an apparent decrease in the number of nerve

branches in the coronal portion of the pulp : in comparison with control pulp.

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