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Vitalometer testing of primary and permanent canine teeth*

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Abstract

Vitalometer tests were performed on 108 primary canines in 48 children from 5 through 10 years of age and on 40 permanent canines in 20 adults. Mean readings increased for each age in children with standard deviations increasing for each age up to the 10 to 11 group. Readings from adults were significantly higher than for each age group from 6 through 10 years, but with some overlap of ranges. Readings for children in the 10 to 11 age group were significantly higher than for the 6 to 7 age group.

Introduction

Pain sensation of primary teeth has not been placed in perspective relative to permanent teeth. Doubts still exist regarding pain sensory capabilities even though use of local anesthesia has gained wide acceptance for restorative procedures.

Several parameters are considered in studying the problem. Differences exist in innervation levels of different primary teeth. In studies of both cat and man, permanent incisors had significantly more myelinated axons than primary incisors; mean numbers of unmyelinated axons were also higher in permanent incisors, but differences were not significant.[1,2] In man, primary canines had significantly more myelinated axons than permanent canines; the mean number for unmyelinated axons was higher in primary canines but differences were not statistically significant.[1] Intrapulpal myelinated and unmyelinated nerve fibers from both primary and permanent teeth fell into the size range assumed to involve pain and temperature sensation. A small percentage of axons has been shown to be associated with autonomic function.[3,4] Detailed studies on innervation levels are lacking for primary molars. Stage of root resorption affects number of nerve fibers entering the teeth with the number decreasing once the apex is resorbed away.[1]

A second consideration is the nerve endings in teeth. While nerve endings have been demonstrated in teeth,[5,6] no comprehensive quantitative study exists regarding the number and localization of these endings. Various mechanisms have been proposed to explain excitation of dental nerves. These include nerve endings in the dentin responding directly to the stimulus, an indirect hydrodynamic mechanism where dentinal tubule contents are displaced by the stimulus, and odontoblasts which are coupled physiologically to nerves and function as receptors.

A third consideration is the accuracy and significance of physiologic tests. A variety of opinions exist on reproducibility in quantitating responses to electrical stimulation of teeth. The test most familiar to dentists is the vitalometer. Vitalometers widely used in this country have a high frequency and are powered either by batteries or line current.[7] Pulsating current-negative polarity vitalometers may become available. A consensus is that they will determine a general level of sensation, but is crude considering the number of variables which can influence readings.[8,9] Reproducibility of vitalometer readings will be influenced by patient age, mental capacity, ability to cope with stress in the dental setting, and inhibitions to respond to stimuli. Sensitivity of permanent teeth depends on stage of root development. Sensitivity studies in man have shown that a greater stimulus is needed to elicit a response from a tooth with an open apex than with a closed apex.[10,11] In cats, it has been demonstrated that nerve fiber development is not completed until the apex has closed.[12]

Perhaps the most difficult area to evaluate is patient interpretation of the sensory impulses. Pain is a sensation of discomfort. However, sensitivity tests in human studies are confined to the threshold of sensation or limen which is tolerable but not uncomfortable. This level has been called the "first pain" threshold

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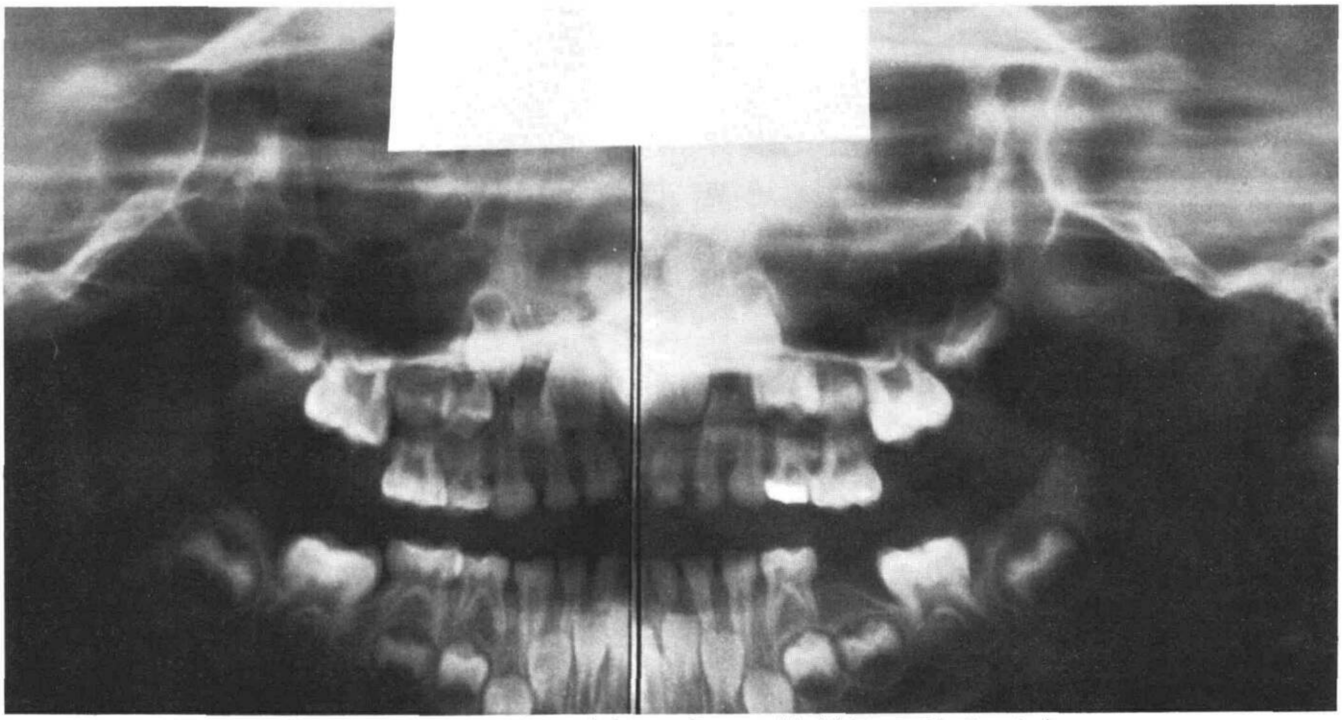

Fig. 1. Panoramic radiograph from a 6-year-old child tested in the study.

and has been assumed to have an association with capacity to perceive pain.[7, 13] Children and adults may differ in their interpretation of similar impulses.

The purpose of the study is to stimulate electrically primary and permanent canines and to compare respective vitalometer readings from children and adults. This will provide data to be compared with anatomical studies and will give insight into threshold levels for pain sensory capabilities of these teeth.

Materials and methods

Vitalometer tests were performed on 108 primary canines from 48 children 5 through 10 years of age and on 40 permanent canines from 20 adults from 20 through 39 years in age (average age 26 years). The most common combination of teeth tested in subjects was one maxillary and one mandibular canine. This combination of teeth was tested in all adults and in 29 children. The remaining children had various combinations resulting in 56 maxillary and 52 mandibular primary canines being tested. The number of tested teeth for each age group is as follows:

Age	*No. of teeth tested*
5–6	10
6–7	32
7–8	25
8–9	15
9–10	13
10–11	10

Examples of persons selected for the study are shown in Figs. 1 and 2.

Several precautions were taken to minimize the error in this method of testing. Children selected for the study were cooperative dental patients tested at times when anxiety was presumed to be minimal—when no injection was administered or at the completion of a restorative procedure in an unanesthetized quadrant. Children with known physical or mental disturbances were excluded. Children were tested consecutively as they were seen in the clinic with no attempt to test one age group separately before testing another.

A battery operated vitalometer† was calibrated with a voltmeter so that intervals on the rheostat could be converted to millivolts. All reported results were secured by one investigator since grounding properties, patient rapport, and mechanics of administering the test may differ among investigators. The tooth was isolated with cotton rolls and dried thoroughly with air. The vitalometer tip moistened with toothpaste was applied to the incisal one-third of the labial surface of the tooth. The vitalometer was turned on and the rheostat slowly advanced until the subject indicated the first sensation, described in advance by the investigator to the child as "warm" or "tingling."

To insure that the child experienced a sensation from the vitalometer, a false-positive test was done with each child for the second tooth tested. The procedure was identical except that the instrument was not on as the rheostat was advanced. If the child responded during the false-positive test, the entire procedure was started over, testing both teeth. Chil-

† Vitapulp, Pelton and Crane Company.

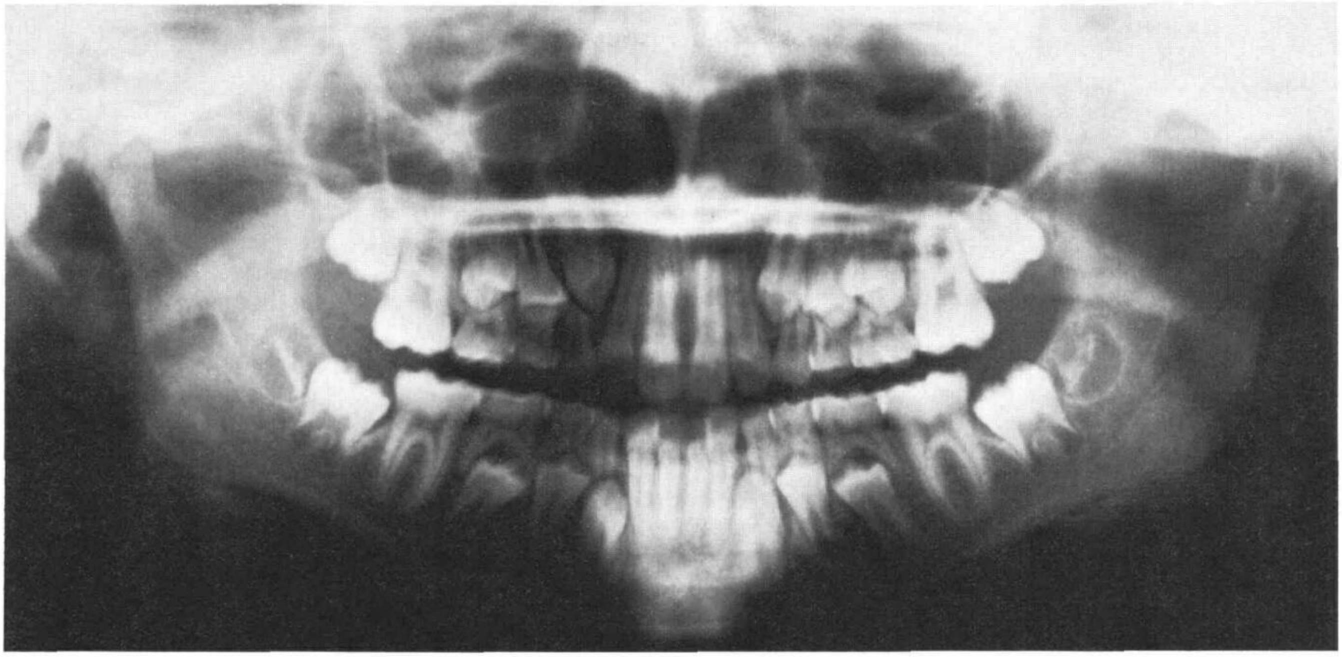

Fig. 2. Panoramic radiograph from a 10-year-old child tested in the study.

dren responding to a second false-positive test were excluded from the study.

Vitalometer application was performed by a pedodontist on the staff at the testing clinic. This provided testing by one familiar with managing children in a dental setting and with the individual children prior to testing.

Intra-operator error was determined by having the principal investigator repeat tests on 16 teeth. Readings were rounded to the nearest ¼ mV. In 13 instances, the second reading was the same as the first; in 2 instances, the difference was ¼ mV; and in one instance the difference was ½ mV. Adults were tested by the principal investigator using the method just described.

Teeth selected for the study were caries-free, restoration-free, nonmobile with normal attrition and had no abrasion and no radiographic evidence of a pathologic condition.

Three primary teeth had radiographic evidence of lateral root resorption. Primary teeth tested had the radiographic image of at least two-thirds of the root present. No attempt was made to make precise assessment of root resorption or to correlate it with vitalometer results. Resorption initiates on the lingual surface and is difficult to quantitate radiographically.

Results

Vitalometer readings obtained from tests on primary and permanent teeth are shown graphically in Fig. 3. Mean readings for primary teeth increased in each age group from age 6 to age 11 but ranges

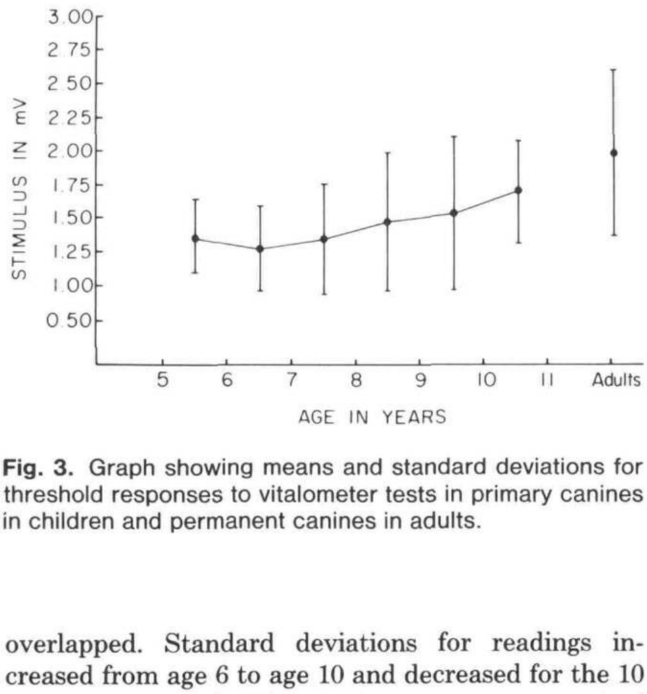

Fig. 3. Graph showing means and standard deviations for threshold responses to vitalometer tests in primary canines in children and permanent canines in adults.

overlapped. Standard deviations for readings increased from age 6 to age 10 and decreased for the 10 to 11 age group. Children in the 5 to 6 age group had slightly higher readings than those in the 6 to 7 group. Children in the 5 to 6 age group were the only ones who were consistently difficult to instruct in test responses.

Readings for adults were significantly higher than for each age group from 6 through 10 years (for 6–7 *vs.* adult, $t = 5.55$, $P < 0.01$; for 9–10 *vs.* adult, $t = 2.23$, $P < 0.05$). No significant difference was found when comparing the 10 to 11 age group with adults ($t = 1.27$). Readings for children in the 10 to 11 age group were significantly higher than for the 6 to 7 age group ($t = 3.29$, $P < 0.01$).

Children with radiographic evidence of lateral root resorption had readings at least 1 mV higher than the mean for the respective age group.

Discussion

Responses to electrical stimulation of primary canines in children and permanent canines in adults are consistent with studies of innervation levels in these teeth.[1] This correlation is of interest even though comprehensive quantitations of nerve endings in teeth remain to be done. Various hypotheses and combinations can be suggested. First, there may be a correlation between the numbers of nerve fibers entering the tooth and the number of nerve endings. Second, regardless of the number of endings, there may be a mechanism for proliferation of pain among nerve fibers or odontoblasts. Although several differences were found statistically, clinically, the differences are lessened by the amount of overlap among various groups.

One interpretation of the results is that the primary canines in the 6 to 7 age group have undergone little or no root resorption and have nearly a full complement of nerve fibers. In succeeding age groups, an increasing proportion of the teeth tested probably have some degree of resorption, loss of nerve fibers and decreased sensation to electrical stimuli. The increased standard deviations for readings in the age groups from 7 through 9 years may be associated with variability in the amount of vertical resorption among subjects. In the 10 to 11 age group teeth which remain have some root resorption and probably a decrease in the number of nerve fibers. In interpreting the results, the greater thickness of enamel and dentin in permanent teeth must be considered since it would modify the results to some extent.

Vitalometer testing of primary molars may be possible. Testing of primary incisors poses several problems. By the time the children are old enough to participate actively in a study, the teeth are extensively resorbed or exfoliated.

The relationship of pulpal responses and interpretation of stimuli as painful is complex at best. The centers for pain and behavior are interrelated and pain is more than a stimulus and response. This study and previous ones support the idea that primary and permanent teeth have comparable apparatuses for passing along impulses presumed to be sensory for pain.

Conclusions

Qualitative interpretation of the electrical stimuli by the subject is beyond the scope of this study. A child's perception of more intense electrical stimulation or of mechanical stimulation may differ from that of adults. This study and previous ones show some similarities. Canines from children and adults are in the same realm regarding the number of sensory nerve fibers entering the teeth; physiologically they are similar in their thresholds for response to electrical stimuli.

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ADA House of Delegates Issues Statement on Dental Caries in Infants

The following statement was issued by the 1978 ADA House of Delegates:

"As soon as a child's teeth begin to erupt at about six months of age, they are susceptible to decay. As is the case with older children and adults, the infant's consumption of readily fermentable carbohydrates stimulates the growth of bacteria. The bacteria form dental plaque, a gelatinous mass that adheres to the teeth, breaking down the carbohydrates to produce acids that attack dental enamel and cause decay.

Dental decay is directly related to the frequency of consumption and length of time that a readily fermentable carbohydrate remains in the mouth. Oral clearance of readily fermentable carbohydrates therefore is essential to maintain dental health. Oral clearance is facilitated by the provision of liquids for only short, discreet time periods.

Accordingly, the following feeding practices which do not permit adequate oral clearance of readily fermentable carbohydrates and may be especially deleterious to the dental health of an infant, are not recommended:

1. Putting the infant to bed with a bottle of milk, juice, formula or sugar solution. Not only may the continuing access to the readily fermentable carbohydrate be harmful, but the solution may pool around the teeth and remain in the mouth for an extended period of time when an infant reclines during feeding.
2. Breast-feeding or bottle-feeding a child who is able to drink from a cup. The length of time necessary to consume a liquid through breast or bottle feeding is much greater than the length of time necessary to consume an equivalent amount of liquid from a cup.

These practices may result in a condition called "nursing bottle mouth," or destruction of most of the infant's teeth by decay. The entire crowns of the teeth of a "nursing bottle mouth" victim may be very difficult to restore. Despite the young age of the child, some of the decayed teeth may have to be removed.

To prevent "nursing bottle mouth" and to otherwise safeguard an infant's dental health, the American Dental Association recommends that parents:

1. Provide a balanced diet for the infant, avoiding sugar-rich foods and the addition of sugars to food whenever possible. Read the product label listing contents. Sucrose, dextrose and corn syrup, all common ingredients of food products for infants, are readily fermentable carbohydrates.
2. Hold an infant during feeding rather than putting him to bed with a bottle. If an infant must have a bedtime or naptime bottle for comfort, fill it with water only.
3. Offer liquids exclusively from a cup as soon as possible. Usually children over twelve months of age are able to drink from a cup.
4. If the community does not have fluoridated water, the family dentist or physician may prescribe a dietary fluoride supplement for the child. If the infant is nourished exclusively by breast-feeding, a dietary fluoride supplement may be necessary.
5. Clean the infant's teeth after each feeding with a dampened soft toothbrush, clean washcloth or gauze pad to remove plaque."