Evaluation of age-related changes with cross-sectional CT imaging of teeth

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ABSTRACT

Tooth pulp atrophy occurs with increasing age. An age estimation procedure using dental cone beam computed tomography (CBCT) imaging was developed. Clinical dental CBCT images of 60 patients (aged from 20 to 80 years) were evaluated. The ratio of the cross-sectional area of the pulp cavity to the cross-sectional area of the tooth (pulp cavity ratio) was calculated. The pulp cavity ratio in the labio-lingual plane of the mandibular anterior teeth and the mesio-distal plane of the maxillary anterior teeth was strongly correlated with the patients' age. The pulp cavity ratio of anterior teeth may be a useful parameter for estimating age.

Keywords: Dental CBCT, dental pulp cavity, anterior tooth, atrophy of dental pulp, estimate age

1. INTRODUCTION

In the field of dentistry, it is known that the dental pulp cavity becomes smaller with increasing age[1]. Although the atrophy of dental pulp occurs as a result of various factors such as caries, hyperesthesia and attrition[2,3], the main contributing factor is aging. Imaging of the dental pulp cavity may be useful in forensic dentistry to estimate the age of the victims of disasters and accidents. However, it is difficult to quantitatively evaluate the size of the dental pulp cavity because of its small size and complicated morphology. Therefore, we examined the cross-sectional area of the dental pulp cavity in anterior teeth. The aim of this study was to develop an age estimation procedure using dental cone beam computed tomography (CBCT) imaging of the jaws.

2. METHODOLOGY

As an initial study, using a dental CBCT system (Veraviewepocs3D, Morita Co., Kyoto, Figure 1), images of a collection of anterior tooth samples were obtained to define adequate three-dimensional imaging parameters including the type of rendering technique, the direction and position of the cross-sectional planes, and the thickness of the sectional images. The field of view was 80 mm in diameter and 80 mm in height. The objective teeth were scanned at an x-ray setting of 80 kV, 5 mA and 10 seconds exposure. The dental pulp cavity was observed in the labio-lingual, mesio-distal and axial cross-sectional planes. These cross-sectional planes were set perpendicular and/or parallel to the tooth axis.
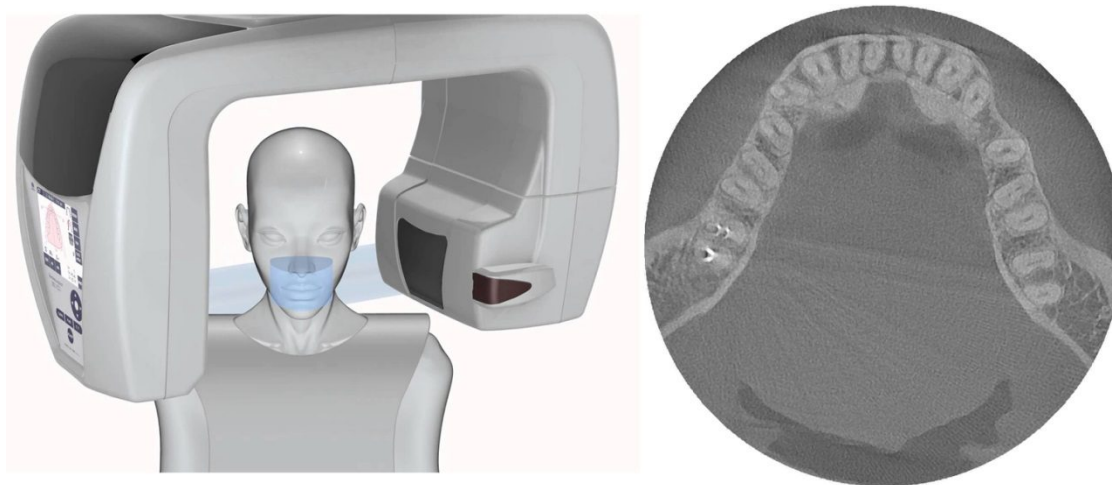

Figure 1: Dental CBCT system and schematic drawing of the field of view (FOV) setting (left). An axial slice of a CBCT image of the mandible with an 80 mm FOV (right).

As the next step, clinical dental CBCT images of 60 patients were evaluated to study the correlation between the cross-sectional area of the dental pulp cavity and the patient's age (Figure 2). The age of the patients ranged from 20 to 80 years (average 48.3 years). The ratio of the cross-sectional area of the pulp cavity to the cross-sectional area of the entire tooth (pulp cavity ratio) was evaluated (Figure 3).

These studies were performed with the approval of the Ethics Committee of Asahi University School of Dentistry.
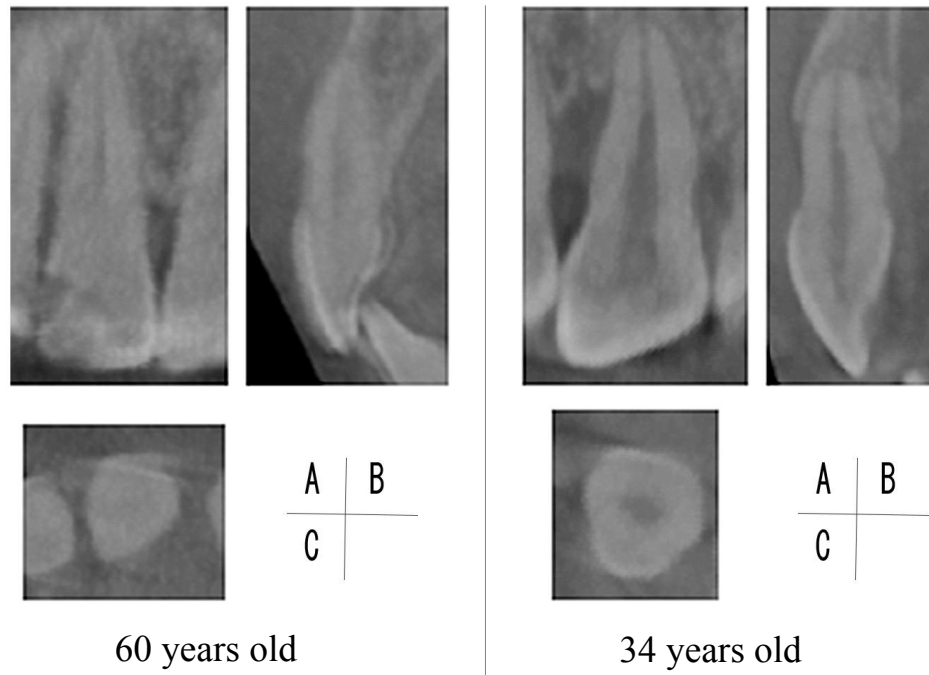
Figure 2: CBCT images of the dental pulp cavity of a 60-year-old subject and a 34-year-old subject, showing the mesio-distal (A), labio-lingual (B) and axial (C) cross-sectional view of the maxillary central incisors.
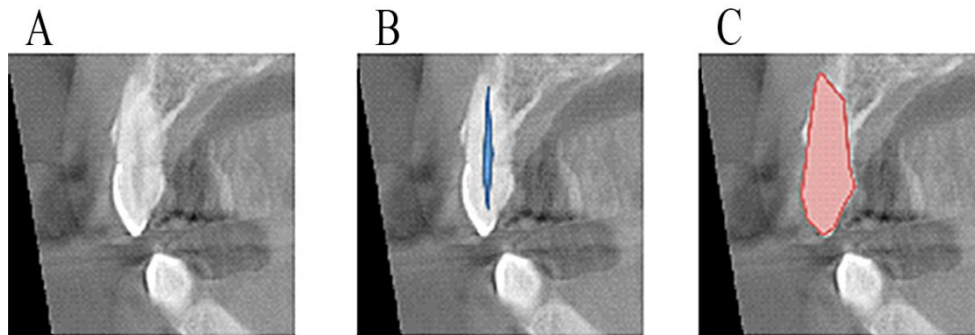

Figure 3: Original labio-lingual cross-sectional image of a maxillary incisor (A), segmentation of the pulp cavity area (B) and the entire tooth area (C).

3. RESULTS

As a three-dimensional CT imaging technique to depict the dental pulp cavity, it was found that the average (ray-sum) and minimum intensity projection (minIP) images with a thickness of approximately 2 mm were appropriate to measure the area of the pulp cavity in anterior teeth. Regarding the pulp cavity ratio in clinical CBCT images, the labio-lingual plane of the mandibular anterior teeth and the mesio-distal plane of the maxillary anterior teeth were strongly correlated to the age of subjects (Figure 4).
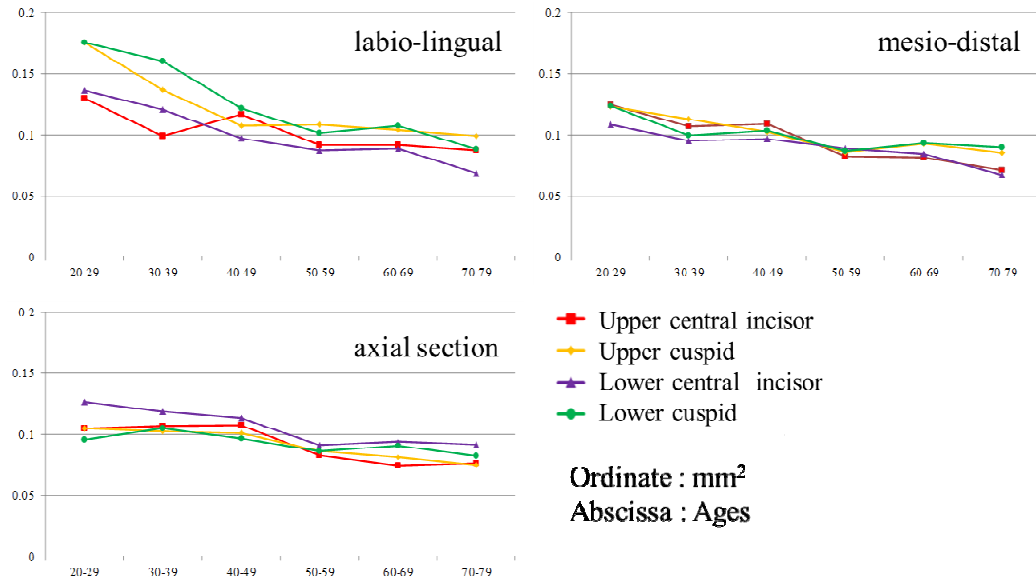

Figure 4: Age-related change in the pulp cavity ratio in bimaxillary incisors and cuspids.

4. DISCUSSION

Several previous studies have evaluated age-related atrophy of the dental pulp using CT. One previous study[4] measured the volume of the pulp cavity in extracted molar teeth using micro-CT images, and found that the topography of the molar pulp cavity was complicated. Additionally, precise image segmentation of the pulp cavity was necessary to measure the volume. Therefore, we chose to use anterior teeth because of the less complex shape of the dental pulp, and because anterior teeth are more likely than molars to be retained in older subjects.

Dental CBCT has become a popular tool in dental clinics, but few studies have been conducted investigating age estimation in vivo. Results from the present study clearly suggest that dental CBCT can be used for forensic purposes. One drawback of dental CBCT is the inaccuracy of the CT number (as measured by the Hounsfield Unit) [5,6], making segmentation of the pulp cavity difficult. Therefore, we decided to measure the cross-sectional area of the pulp cavity rather than the volume. Because the size of the teeth is subject to individual variation, we calculated the ratio of the cross-sectional area of the pulp cavity to the cross-sectional area of the entire tooth (pulp cavity ratio) to estimate age. Our findings revealed that the atrophy of the dental pulp cavity in anterior teeth is a useful indicator for estimating age. Further research is required to develop a computer algorithm to automatically measure the pulp cavity ratio[7].

5. CONCLUSION

The pulp cavity ratio of anterior teeth may be a useful parameter for estimating age. However, consideration needs to be given to the most suitable cross-sectional plane to estimate age among different types of teeth.

6. CLINICAL RELEVANCE/APPLICATION

Dental CBCT imaging is a useful tool for estimating the age of patients by means of evaluating the size of tooth pulp cavity.

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