A comparative study of the cemental surfaces of teeth with and without periodontal diseases by scanning electron microscopy

Ratthapong Worawongvasu
B.Sc., D.D.S., Specialty Certificate in Oral Pathology, M.S. Department of Oral and Maxillofacial Pathology, Faculty of Dentistry, Mahidol University.

Abstract

Objectives: The purpose of this study was to compare the cemental surfaces of normal teeth with those of teeth with periodontitis by scanning electron microscopy.

Materials and methods: Five normal premolars and 5 premolars with periodontitis were used in this study. The specimens were collected from the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Mahidol University and private dental clinics. After extractions, the teeth were stored in 10% formalin until required. The specimens were cut in mesiodistal directions, immersed in 5.25% sodium hypochlorite and then dehydrated using increasing ethanol concentrations (two changes 15 minutes each): 50%, 60%, 70%, 85%, 95%, 100% and dried by leaving the specimens at room temperature for 24 hours, mounted on aluminum stubs, coated with gold, 100-300 Å thick, with an ion sputter coater, and viewed with a JEOL JSM-6610 LV scanning electron microscope, at three magnifications: X500, X1,000, and X 2,000. The photomicrographs were described and compared between 2 groups.

Results: The nondiseased roots showed an area with a pebbly appearance. Sharpey fibers appeared as low confluent mounds and dish-topped projections. The surfaces of periodontally diseased roots were uneven pebbly. The cemental surfaces appeared as numerous low confluent mounds or dish-topped projections and were covered by irregular, thin and sheet-like deposits. Discrete clusters of spherical mineral particles were distributed over the surfaces of the mounds. Each mound was low and consisted of close-packed Sharpey fibers. In between mounds, presence of some intrinsic matrix fibers parallel with the surface was clearly seen. In some areas, some elevations were dish-topped and contained intrinsic matrix fibers parallel with the surface. In areas of dense deposits, the mineral particles appeared as spherical and irregular thin sheet-like deposits. An extensive area of the root covered by irregular thin sheet-like deposits was seen. In many roots, large, multiloculated resorption bays were seen.

Conclusions: The root surfaces of the normal teeth show no calculus retention and no destruction of the cemental surfaces, but those of the teeth with chronic periodontitis show cemental surfaces which are full of calculus retention and resorption areas which are large and widely distributed.

Keywords: cemental surfaces, cementum, periodontal diseases, periodontitis, scanning electron microscopy, human teeth


Correspondence author:
Ratthapong Worawongvasu
Department of Oral and Maxillofacial Pathology, Faculty of Dentistry, Mahidol University,
6 Yothi Rd., Rajathevi, Bangkok 10400.
Email: ratthapong.wor@mahidol.ac.th
Received: 11 June 2014
Accepted: 15 July 2014
Introduction

Periodontal disease (s) refers to the inflammatory processes that occur in the tissues surrounding the teeth in response to bacterial accumulations (dental plaque) on the teeth. Rarely do these bacterial accumulations cause overt infections, but the inflammatory response (s) which they elicit in the gingival tissue is ultimately responsible for a progressive loss of collagen attachment of the tooth to the underlying alveolar (jaw) bone, which, if unchecked, can cause the tooth to loosen and then to be lost. About 50% of the adult population has gingivitis around three or four teeth at any given time, and 30% have periodontitis as defined by the presence of three or more teeth with pockets of ≥ 4 mm. Between 5 and 15% of those with periodontitis have advanced forms with pockets of ≥ 6 mm. Another 3 to 4% of individuals will develop an aggressive form of periodontal disease, known as early onset periodontitis, between the ages of 14 and 35 years.1

The scanning electron microscopy is a valuable tool in studying the fine details of the organization of the cemental surface.2 There are several previously published reports on the characterization of the cemental surfaces of the periodontally diseased teeth by scanning electron microscopy as follows:

The cementum surface of normal human teeth showed mounds or dish-topped projections where Sharpey fibers entered the surface of the cementum. Intrinsic matrix fibers were parallel with the surface. In areas of active mineralization, the mineralization front consisted of discrete clusters of mineral particles. Resorption bays were either small and isolated or more rarely large and quite deep where excessive force must have occurred.3 In periodontally diseased human teeth, numerous domes or small circular “mounds” were observed on the surfaces of the diseased roots, giving them a pebbly appearance.4 It was suggested that the spread of root resorption was associated with inflammation and the capacity for repair of root resorption was diminished with greater severity of periodontitis.5 The root surface demonstrated irregular pattern of plaque and calculus formation. Calculus appeared as thin and sheet-like deposits.6 The cementum surface had a globular appearance, and holes from the insertion of missing Sharpey fibers. Resorption lacunae could be seen at the suprabony root surface.7

So far, there has been a limited number of studies on the characterization of the cemental surfaces of periodontally diseased teeth. This study aims to compare the cemental surfaces of normal teeth with those of teeth with periodontitis by scanning electron microscopy (SEM).

Materials and methods

A sample of 5 human premolars from patients requiring tooth extraction due to orthodontic reason and 5 human premolars from those requiring tooth extraction due to chronic periodontitis, with an age range between 15 and 40 years, was obtained. All teeth were non-caries, not restored and sound without cracks. The specimens were collected from the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Mahidol University and private dental clinics. After extractions, all teeth were stored in 10% formalin until required. After the teeth were gently handwashed with water and air-dried, each tooth was then sectioned using Micro Cutting Instrument, Struers Accutom-50, Denmark. Two longitudinal sections were obtained by cutting each tooth in half in the mesiodistal (sagittal) plane through the midline of the tooth. Each half was immersed in a 5.25% sodium hypochlorite solution for 24 hours at room temperature to remove soft tissue or organic
substances. After that it was rinsed thoroughly in distilled water, and then dehydrated in a series of graded ethyl alcohol (two changes 15 minutes each): 50%, 60%, 70%, 85%, 95%, 100% and dried by leaving the specimens at room temperature for 24 hours, mounted on aluminum stubs, coated with gold, 100-300 Å thick, with an ion sputter coater, and viewed with a JEOL JSM-6610 LV scanning electron microscope, at three magnifications: X500, X 1,000, and X2,000. To determine whether there was any major variation in the micromorphology in different regions of the root, each root was divided into upper, middle and lower thirds. The photomicrographs were described and compared between 2 groups. Representative electron micrographs showing periodontally diseased and nondiseased (normal) roots were selected for presentation in this paper.

Results

At low magnification, the nondiseased roots showed an area with a pebbly appearance (Figure 1). At higher magnification, Sharpey fibers appeared as low confluent mounds and dish-topped projections (Figure 2). The cementum sometimes fractured away from the root surface and exposed the underlying dentin which was characterized by approximately evenly distributed openings of dentinal tubules (Figure 3). At low magnification, the surfaces of periodontally diseased roots were uneven pebbly. The cemental surfaces appeared as numerous low confluent mounds and were covered by irregular, thin and sheet-like deposits (Figure 4 and Figure 5). In some areas at higher magnification, discrete clusters of spherical mineral particles were distributed over the surfaces of the mounds (Figure 6). Each

Figure 1 A normal cemental surface shows an area with a pebbly appearance. Branching fissures (arrows) are artifacts due to the preparation of the specimen (X1,000).
Figure 2  Sharpey fibers (arrows) appear as low confluent mounds and dish-topped projections (X2,000).

Figure 3  In an area where the cementum fractures away from the root surface, the underlying dentin is exposed and characterized by approximately evenly distributed openings of dentinal tubules (arrows) (X2,000).
Figure 4  In the left half of the field, numerous elevations and depressions give the cemental surface an uneven pebbly appearance. In the right half of the field, the cemental surface is covered by irregular, thin and sheet-like deposits (X1,000).

Figure 5  The cemental surface appears as numerous low confluent mounds. Irregular, thin and sheet-like deposits are also seen at the lower right of the field (X1,000).
mound was low and consisted of close-packed Sharpey fibers. In between mounds, presence of some intrinsic matrix fibers parallel with the surface was clearly seen (Figure 7). In some areas, some elevations were dish-topped and contained intrinsic matrix fibers parallel with the surface. Some of the projections were covered by irregularly-shaped, thin and sheet-like deposits (Figure 8). In areas of dense deposits at low magnification, mineral particles were distributed over the root surface (Figure 9). At higher magnification, the mineral particles appeared as spherical and irregular thin sheet-like deposits (Figure 10). An extensive area of the root covered by irregular thin sheet-like deposits was seen (Figure 11). In many roots, large, multiloculated resorption bays were seen (Figure 12).

**Discussion**

At low magnification, the cemental surfaces of the normal roots appeared pebbly (Figure 1). At higher magnification, Sharpey fibers were seen and appeared as low confluent mounds and dish-topped projections (Figure 2). These findings are in agreement with those reported by Jones and Boyde.\(^3\) In periodontally diseased roots at low magnification, the cemental surfaces were pebbly (Figure 4). At higher magnification, the cemental surfaces consisted of numerous low mounds (Figure 5 to Figure 7) and dish-topped projections (Figure 8). These findings are similar to those reported by Barton and Van Swol.\(^4\) and Bimstein et al.\(^7\) In this study, in some areas, the cemental surfaces were covered by irregular, thin and sheet-like deposits (Figure 4, Figure 5, Figure 7, and Figure 8). In other areas, discrete clusters of spherical mineral particles were distributed over the surfaces of the cementum (Figure 6). In areas of dense mineral deposition, the mineral particles appeared as spherical and irregular flat sheet-like deposits (Figure 9 and Figure 10). In addition, a large area of the root surface was

![Figure 6](image-url)  
*The cemental surface appears as low mounds. Discrete clusters of spherical mineral particles are distributed over the surfaces of the mounds. (X2,000).*
A comparative study of the cemental surfaces of teeth with and without periodontal diseases by scanning electron microscopy

Ratthapong Worawongvasu

M Dent J Volume 34 Number 3 September-December 2014

Figure 7 At center, the mound is low and consists of close-packed Sharpey fibers (arrows). In between mounds, presence of some intrinsic matrix fibers parallel with the surface is seen. The mounds surrounding the central area are covered by irregular, thin and sheet-like deposits (X2,000).

Figure 8 At the upper left and upper right, Sharpey fibers appear as dish-topped projections. Each projection contains some intrinsic matrix fibers parallel with the surface. Irregularly-shaped, thin and sheet-like deposits are also seen (X2,000).
Figure 9  Mineral particles are distributed over the root surface (X500).

Figure 10  The mineral particles appear as spherical and irregular thin sheet-like deposits (X2,000).
Figure 11  The root surface is covered by irregular thin sheet-like deposits (X1,000).

Figure 12  A large, multiloculated resorption bay is seen at the middle of the field (X500).
covered by irregularly-shaped thin sheet-like deposits. It seems that individual spherical mineral particles fuse into a plaque-like deposits which showed the pattern of calculus deposition on the roots of the teeth with chronic periodontitis. In many areas, widely extended areas with resorption were found (Figure 12). Jones and Boyde\(^3\) reported that in normal roots, resorption bays were either small and isolated, often seen in newly erupted teeth; or, more rarely, large and quite deep where excessive force must have occurred. The resorption bays in this study were large and found in many teeth; therefore, it suggests that the spread of root resorption may be associated with inflammation in periodontally diseased teeth. This finding agrees with that reported by Crespo Abelleira et al.\(^5\).

In conclusions, the root surfaces of the normal teeth show no calculus retention and no destruction of the cemental surfaces, but those of the teeth with chronic periodontitis show cemental surfaces which are full of calculus retention and resorption areas which are large and widely distributed.

**Acknowledgements**

The author thanks Chayada Tianchai, a researcher of Research Service Center, Faculty of Dentistry, Mahidol University, for her help in operating the scanning electron microscope and Kasidit Chavitrutaikul, Charwis Rattanasuwanwut, Bordin Worakamon, Wanasapon Plengsuree, and Puttinan Chankeeree, the fourth year dental students in the course of DTID 431 Research project and DTID 451 Research project, Faculty of Dentistry, Mahidol University, for their help in collecting and preparing the specimens and examining them by using scanning electron microscopy. This research is part of the course DTID 431 Research project, first semester and DTID 451 Research project, second semester, academic year 2012. This work was supported by Faculty of Dentistry’s Fund, Faculty of Dentistry, Mahidol University.

**Funding:** Faculty of Dentistry, Mahidol University

**Competing interests:** None declared

**Ethical approval:** The Mahidol University Institutional Review Board with Protocol No. MU-DT/PY-IRB 2012/044.0709.

**References**