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Original Article

Physiological Wear of Natural Anterior Teeth after Two Years

Chantana Tulapornchai
Lecturer
Department of Prosthodontics
Faculty of Dentistry, Mahidol University

Trinuch Eiampongpaiboon
Lecturer
Department of Prosthodontics
Faculty of Dentistry, Mahidol University

Correspondence to:
Dr. Chantana Tulapornchai
Department of Prosthodontics
Faculty of Dentistry,
Mahidol University
6 Yothi Street, Ratchathewi, Bangkok 10400
Tel: 02-2036441 Ext. 114
Fax: 02-2036440
E-mail: dtcte@mahidol.ac.th

Abstract

The objective of this study was to determine volume loss due to physiological wear of natural anterior teeth at one year and two years. Eighteen subjects with good medical and dental health, average age 37±9 years, were recruited for this study. Impressions of maxillary and mandibular arches were taken using polyvinyl siloxane impression material at baseline, one-year, and two-year appointments. Replica models were made using synthetic stone. Volume loss or wear of both maxillary and mandibular natural central incisors and canines was obtained by comparing the surface of the original model with those of the one-year and two-year models using 3D laser scanner. Statistical analysis of the mean values was performed using Student's t-test at a significant level of 0.05. The results showed that the means volume loss of maxillary central incisor and canine after two years were 0.46±0.27 mm^3 and 0.31±0.07 mm^3, respectively. The means volume loss of mandibular central incisor and canine after two years were 0.09+0.06 mm^3 and 0.07±0.02 mm^3, respectively. The increases in means volume loss of maxillary central incisor and canine were observed after two years, and significant differences were found between the means volume loss of all maxillary anterior teeth at one year and the means volume loss at two years ($p < .05$). The means volume loss of maxillary anterior teeth were significantly higher than those of mandibular anterior teeth at two years ($p < .05$). In conclusion, significant differences were found between the means volume loss of all maxillary anterior teeth at one year and the means volume loss at two years. The means volume loss of maxillary anterior teeth were significantly higher than those of mandibular anterior teeth at two years.

Key words: laser scanner; natural anterior teeth; wear

Introduction

Enamel wear is a progressive phenomenon that occurs during normal masticatory functions. Loss of anatomic form as a result of wear can occur over a period of time. Wear rate may vary between human subjects depending upon several factors, including eating behavior, maximum clenching force, bruxism, and opposing restorative materials.[1,2] Compromised functions and esthetics are the results from this wear phenomenon, especially in the anterior region. Anterior teeth are essential parts of the masticatory system. Not only guiding the normal chewing pattern, protecting of the posterior teeth during excursive movements is also the major function in mutually protected occlusion.[3] Loss of anterior tooth would affect inevitably the chewing efficacy, phonetic ability and esthetic property of individuals.

Wear measurement is a time-consuming process. Vertical height loss and volume loss are used in quantifying wear of tooth enamel and other restorative materials in several in vitro studies.[4-8] For in vivo study, tooth replicas can be obtained from impression taken intraorally. Matching between baseline and recall models can be made using matching software.[9,10] Generally, most wear studies were focused on wear of tooth enamel that opposed to some restorative materials. It is well-known that ceramics are harder and cause more enamel wear than gold alloys and composite resins.[5-7] However, information about the baseline wear rate of natural tooth is limited. It is very difficult to make a conclusion whether any restorative material produces significant wear of opposing enamel if there is no information about wear of tooth-to-tooth contacts that occur naturally. The objective of this study was to determine volume loss due to physiological wear of natural anterior teeth at one year and two years.

Materials and methods

Eighteen subjects with good dental health were recruited from the pool of subjects on the waiting list of the Faculty of Dentistry, Mahidol University. These subjects were screened to exclude individuals with poor medical health. All selected subjects had at least 20 teeth including all natural anterior teeth, healthy periodontal tissues, were free of active periodontal disease and caries, and showed no evidence of bruxing. All anterior teeth had occlusal contacts with their antagonists and their contact areas were identified. No anterior cross-bite occlusion was observed in this study. For these 18 subjects, 3 were men and 15 were women with ages ranging between 20 and 56 years with the mean age of 37±9 years.

The maximum clenching force capability of each subject was determined using a bite force gauge and impressions of maxillary and mandibular arches were taken using polyvinyl siloxane impression material (Express®, 3M, ESPE, USA) by double impression technique at the beginning of this study. Replica models were made using synthetic stone (Fujirock®, GC Co Ltd., Japan) and marked as baseline models. The mixing of synthetic stone was carried out using a power-driven mechanical spatulator with the recommended water to powder ratio. The mixed stone was poured slowly into an impression on a vibrator to avoid trapping air bubbles in the critical areas. After setting, all replica models were checked to confirm the completeness of the occluding areas of all teeth.

All patients were recalled after one and two years. At the recall appointments, the occlusal contacts were observed and photographically recorded. Impressions of maxillary and mandibular arches were taken using polyvinyl siloxane impression material by double impression technique at one-year, and two-year appointments. Replica models were made using synthetic stone. These models were marked as one-year, and two-year models. Volume losses of both maxillary and mandibular natural central incisors and canines were obtained by comparing the surface of the baseline model with those of the one-year and two-year models using 3D Laser-scanner (Etkon, Willytec GmbH, Gräfefing, Germany). A 3D Laser-scanner used in this study was previous described in another study.[9,10] The scanner used a laser beam that was projected onto the surface being studied. After scanning, the occlusal area of each tooth was outlined for volume loss calculation. A superimposition of images of two replicas (the baseline model and the one-year or two-year model) using at least three reference points were made using a matching software and then the amount of the spatial differences between these two images was measured. The matching effectiveness between two surfaces was monitored during each wear volume determination in order to comply with the manufacturer's recommendation.

Statistical analyses of the means volume loss were performed using the Student's t-test at a significant level of 0.05 to determine the differences between volume loss of natural anterior teeth at one year and two years.

Results

Representative images of natural teeth are shown in Fig. 1. The means volume loss of natural anterior teeth are summarized in Table 1 and Fig. 2. The increases in means volume loss of maxillary central incisor and canine were observed after two years, and significant differences were found between the means volume loss of all maxillary anterior teeth at one year and those at two years ($p < .05$). The means volume loss of maxillary anterior teeth were significantly higher than those of mandibular anterior teeth at two years ($p < .05$).

The maximum clenching force for 18 subjects ranged between 145 and 763 N. The relationship between maximum clenching force and volume loss was determined using a linear regression analysis (Fig. 3). The result showed that there was no significant relationship between maximum clenching force and the volume loss of maxillary central incisor ($R^2 = 0.09$) and maxillary canine ($R^2 = 0.001$).

Representative scanned images of replica models of maxillary natural central incisors and canines before and after matching are shown in Fig. 4.

Fig. 1 *Representative photographs of natural teeth (a) occluded position; (b) maxillary arch, and (c) mandibular arch*

Table 1 *The means volume loss of natural anterior teeth*

Anterior teeth	Means volume loss of central incisors (mm^3)		Means volume loss of canines (mm^3)	
	One-year	Two-year	One-year	Two-year
Maxillary	0.29±0.14	0.46±0.27	0.21±0.06	0.31±0.07
Mandibular	-	0.09±0.06	-	0.07±0.02

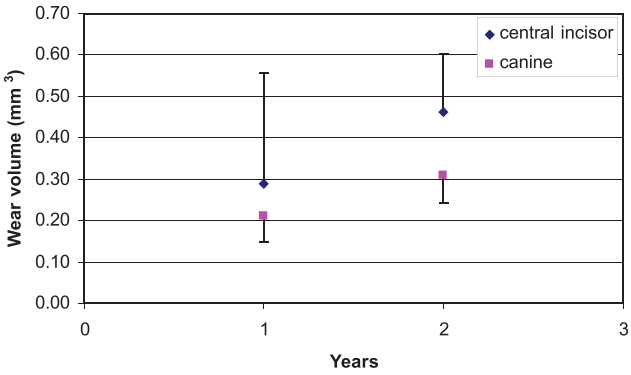

Fig. 2 *Volume loss of maxillary central incisor and canine at one year and two years*

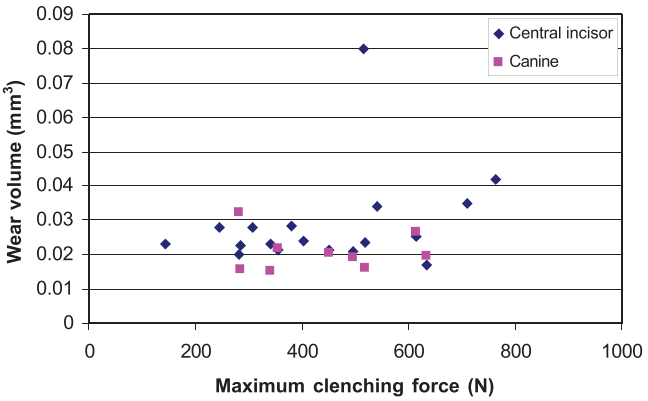

Fig. 3 *The relationship between maximum clenching force and volume loss of maxillary central incisor and maxillary canine*

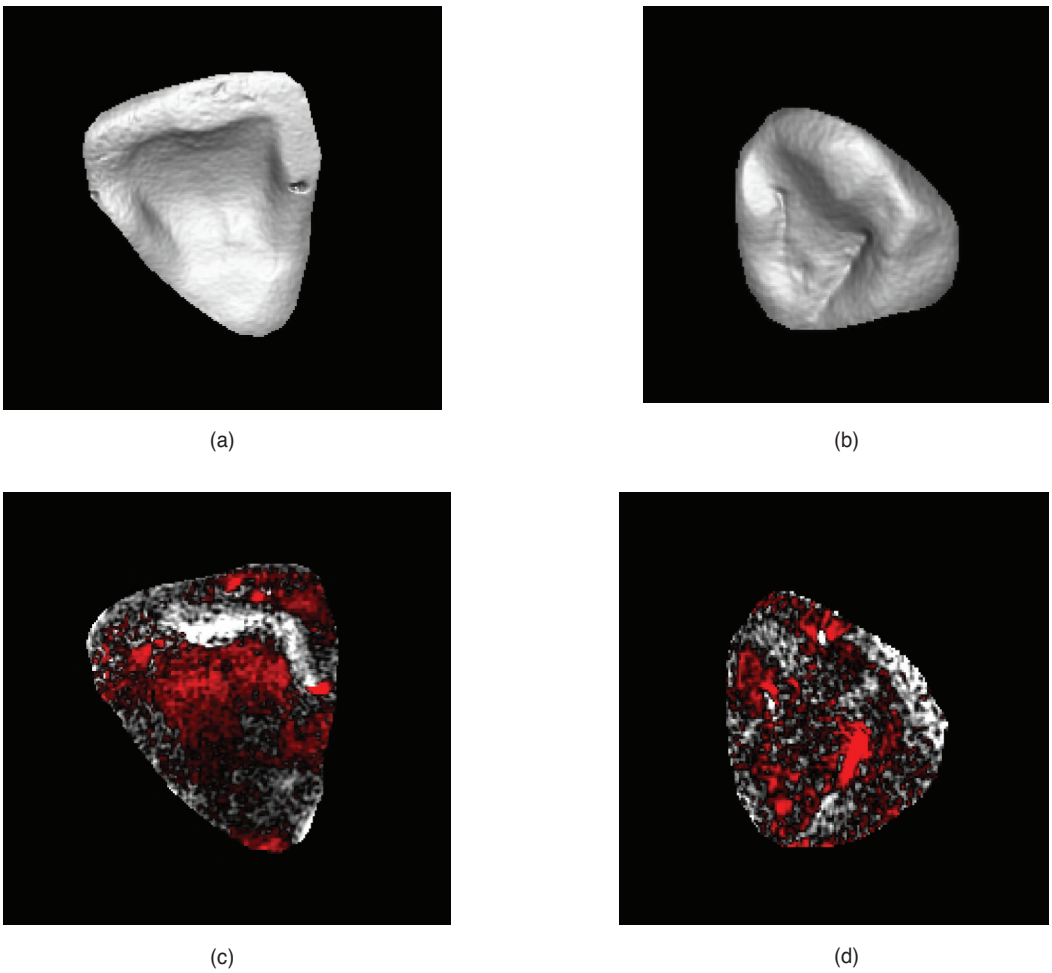

Fig. 4 *Scanned images of replica models before matching the surfaces of (a) maxillary natural central incisor and (b) maxillary natural canine; and after matching the surfaces of (c) maxillary natural central incisor and (d) maxillary natural canine. The red area indicates the negative volume or wear*

Discussion

The increases in volume loss for maxillary central incisor and canine after two years were 59% and 48%, respectively. The amounts of volume loss of maxillary central incisor were greater than those of maxillary canine at one year and two years. The means volume loss of all maxillary anterior teeth were significantly higher than those of all mandibular anterior teeth at two years ($p < .05$). This was not unexpected because the difference in contact areas between maxillary and mandibular teeth was noticeable. Because the size of a maxillary central incisor is larger, it may contact simultaneously with two mandibular incisors. Also, the whole lingual inclines of the maxillary anterior teeth are in contact with the opposing teeth during intercuspation contact and eccentric movements.[11] In contrast, only their incisor edges of mandibular anterior teeth travel along the lingual inclines of the maxillary anterior teeth during all movement directions. Therefore, the contact area of maxillary incisor is larger and results in more wear volume comparing with the incisal edge contact of mandibular incisor.

The amount of wear volumes of maxillary central incisor and canine are comparable to that of premolar tooth (0.21±0.06 mm^3) at one year and higher than that of premolar tooth (0.28±0.10 mm^3) at two years.[10] The reason for high wear volume of anterior teeth may be the larger contact area both in the intercuspation position and eccentric movements (Fig. 5). The large contact area of anterior teeth includes the horizontal and vertical wear facets that were reported for tooth wear analysis.[11] In addition, separation of posterior teeth during protrusive and lateral movements may be the reason for low wear volume of premolars. Wear of molar tooth was higher than those of anterior teeth both at one year and two years. Molar teeth are the main sites for masticatory function and it is reasonable to have higher wear volume.

Wear of natural teeth occurs regularly during normal masticatory function. Several factors have been proposed to involve in wear process but there is limited information in how and how much wear occurs during functions. Wear volumes for natural teeth were reported from few in vivo studies, but the results varied among these studies.[12,13] Wear volumes as low as 0.047±0.06 mm^3 for premolars and 0.063±0.09 mm^3 for molars were reported for young adults after two years.[12] The means wear depth were also reported as 15.49-15.88 μm for premolars and molars. The mean wear volume for canines was 0.173±0.53 mm^3 which was higher than those of posterior teeth. The mean wear depth of canines was 28 μm after two years.[12] The results from another study reported only wear depth of premolars and molars after two years as 54±51 μm, and 91±59 μm, respectively.[13] Even the wear volume of canines described in previous study[12] was low compared with the result from this study, but its high standard deviation reflects a high variation between human subjects. The different techniques used for wear measurement may be one reason for describing a large variation obtained from different studies. Because of limited information in wear of tooth enamel, the results obtained from this study can be used as baseline information when comparing wear characteristics of dental restorative materials and opposing enamel, especially for in vitro studies that are simple and less time-consuming than a clinical study.

Fig. 5 *Contact area of anterior teeth in the intercuspation position and eccentric movement (a) maxillary arch and (b) mandibular arch*

Conclusions

1. Significant differences were found between the means volume loss of all maxillary anterior teeth at one year and the means volume loss at two years ($p < .05$).

2. The means volume loss of maxillary anterior teeth were significantly higher than those of mandibular anterior teeth at two years ($p < .05$).

3. There was no significant relationship between maximum clenching force and the wear volume of maxillary central incisor ($R^2 = 0.09$) and maxillary canine ($R^2 = 0.001$).

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คณะทันตแพทยศาสตร์ มหาวิทยาลัยมหิดล
6 ถนนโยธี เขตราชเทวี กรุงเทพฯ 10400
โทรศัพท์: 02-2036441 ต่อ 114
โทรสาร: 02-2036440
อีเมล: dtcte@mahidol.ac.th

บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาปริมาณการสึกเนื่องจากการสึกทางกายภาพของฟันหน้าธรรมชาติในเวลา 1 ปีและ 2 ปี ทำการศึกษาในผู้ที่มีสุขภาพร่างกายและสุขภาพฟันที่ดี 18 ราย อายุเฉลี่ย 37±9 ปี โดยการพิมพ์ปากทั้งขากรรไกรบนและขากรรไกรล่างด้วยวัสดุพิมพ์ปากซนิดโพลีไวนิล ไซลอกเซนในการนัดครั้งแรก 1 ปี และ 2 ปี ตามลำดับ ทำแบบจำลองของแต่ละเวลาโดยใช้ปลาสเตอร์หินสังเคราะห์ หาปริมาณการสึกของทั้งฟันตัดและฟันเขี้ยว ทั้งบนและล่าง โดยการเปรียบเทียบพื้นผิวของแบบจำลองปีที่ 1 และปีที่ 2 กับแบบจำลองเริ่มต้นด้วยเครื่องเลเซอร์สแกนเนอร์ 3 มิติ นำค่าเฉลี่ยมาวิเคราะห์ทางสถิติด้วยวิธีทดสอบสติวเด้นท์ที ที่ระดับนัยสำคัญ .05 ผลการศึกษา พบว่าค่าเฉลี่ยของปริมาณการสึกของฟันตัดบนและฟันเขี้ยวบนในระยะเวลา 2 ปี เท่ากับ 0.46±0.27 มม^3 และ 0.31±0.07 มม^3 ตามลำดับ ค่าเฉลี่ยของปริมาณการสึกของฟันตัดล่างและฟันเขี้ยวล่างในระยะเวลา 2 ปี เท่ากับ 0.09±0.06 มม^3 และ 0.07±0.02 มม^3 ตามลำดับ ค่าเฉลี่ยปริมาณการสึกของฟันตัดบนและฟันเขี้ยวบนเพิ่มขึ้นใน 2 ปี และค่าเฉลี่ยปริมาณการสึกของฟันหน้าบนเพิ่มขึ้นอย่างมีนัยสำคัญ เพื่อเปรียบเทียบในระยะ 1 ปี และ 2 ปี ที่ระดับความเชื่อมั่น .05 และค่าเฉลี่ยปริมาณการสึกของฟันหน้าบนมากกว่าฟันหน้าล่างอย่างมีนัยสำคัญที่ระยะเวลา 2 ปี ($p < .05$) โดยสรุปพบว่าค่าเฉลี่ยปริมาณการสึกของฟันตัดบนและฟันเขี้ยวบนเพิ่มขึ้นอย่างมีนัยสำคัญเมื่อเปรียบเทียบในเวลา 1 ปี และ 2 ปี ค่าเฉลี่ยปริมาณการสึกของฟันหน้าบนมากกว่าฟันหน้าล่างอย่างมีนัยสำคัญที่ในเวลา 2 ปี