UNIVERSIDADE FEDERAL DE UBERLÂNDIA
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DANO AO ESMALTE NA REMOÇÃO DE CONTENÇÃO DENTAL – EFEITO DOS TIPOS DE ILUMINAÇÃO E DE INSTRUMENTOS ROTATÓRIOS

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Trabalho de conclusão de curso apresentado a Faculdade de Odontologia da UFU, como requisito parcial para obtenção do título de Graduado em Odontologia.

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RESUMO

A remoção da resina composta usada na contenção dentária para tratamento do trauma dental pode resultar em danos irreversíveis ao esmalte dental. O objetivo deste estudo *in vitro* foi avaliar a influência da iluminação adicional e diferentes tipos de brocas na ocorrência de danos ao esmalte dental. Foram criados quinze modelos de anterior da maxila com quatro dentes incisivos bovinos, em seguida foram digitalizados usando sistema de escâner de laboratório (s600 ARTI; Zirkonzahn). Em seguida, contenção com fio de nylon flexível foi criada usando, condicionamento ácido do esmalte, sistema adesivo de dois passos e resina composta de alta fluorescência. Um único operador removeu todas as contenções definidas por 6 grupos experimentais (n = 10): gerados por 2 fatores de estudo: A. tipo de iluminação (1. luz violeta de baixo custo; 2. Fonte de luz VALO Cordless (Ultradent) com filtro violeta; ou 3. sem iluminação adicional); e B. instrumento rotatório (1. ponta diamantada; ou 2. broca multilaminada). Nova digitalização foi realizada e sobreposta à inicial usando o software Cumulus (Minnesota). Foi realizada análise qualitativa e quantitativa da perda de esmalte e os dados analisada estatisticamente empregando ANOVA fotorial (3x2) seguido do teste Tukey foram usados com nível de significância de 5%. O uso da luz violeta presente na lanterna violeta de baixo custo e VALO Cordless resultou em significativamente menores danos na superfície do esmalte do que os grupos sem luz violeta adicional (P <0,001). Não houve diferença estatística no desempenho da lanterna de baixo custo e a VALO Cordless. No entanto, houve significância para a interação entre o instrumento rotatório e tipo de iluminação. A iluminação fluorescente facilitou a remoção da resina composta utilizada nas contenções dentais com menor risco de dano ao esmalte dental. A ponta diamantada apresentou maiores danos ao esmalte quando nenhuma luz violeta foi utilizada.

Palavras-chave: contenção semi-rígida; remoção de resina; luz violeta; avaliação 3D; zirkonzahn.

ABSTRACT

Background/Aim: Removal of composite resin used for dental trauma splint may result in irreversible damage to enamel. The aim of this in vitro study was to evaluate the influence of additional illumination and different bur types on the generation of damage to dental enamel.

Materials and Methods: Fifteen maxillary models with four bovine teeth were generated. All models were scanned, using a laboratory scanning systems (s600 ARTI; Zirkonzahn). After a flexible nylon splint was created using etch-and-rinse adhesive and fluorescence resin composite. One operator removed all splinting. The 6 groups experimental groups (n=10) were generated by 2 study factors: lighting type (1. low cost violet light; 2. VALO cordless with violet filter; or 3. without additional illumination) and rotatory instrument (1. diamond bur; or 2. multifluted tungsten-carbide bur). A new scanning was performed and superimposed on the initial scan using Cumulus software. A qualitative and quantitative analysis of enamel loss was performed and statistically analyzed. Two-way ANOVA and Tukey's post-hoc test were used at a 5% significance level.

Results: The use of violet lighting presented in low-cost violet flashlight and VALO Cordless resulted in significantly lower damage on enamel surface than the groups without additional violet light ($P < 0.001$). There were no statistical difference between low-cost flashlight and VALO Cordless. The performance of rotatory instrument is dependent of lighting type used.

Conclusions: Fluorescence lighting facilitated the removal of remnant composite resin used in dental trauma splints, leading to less invasive treatment. The diamond bur presented higher enamel depth values when no additional violet light was used.

Keywords: semi-rigid splint; resin composite removal; violet light; enamel damage.

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1. INTRODUCTION

The high prevalence of dental trauma, represented by more than one billion cases worldwide (1), with a high incidence on young patients every year, emphasizes dental trauma as an important public health matter (2). When the injury causes damage to periodontal tissues, the flexible stabilization is required (3). A nylon-composite splinting is a well known flexible stabilization method that allows the physiological movement of the traumatized teeth, achieving expected periodontal repair (4-6), and it is commonly used due to its esthetic and low cost material (7).

The nylon-composite resin splint are usually applied on the buccal surface of the anterior teeth (4). Its use is temporary (5), and after the healing period the splint needs to be removed, and this procedure, might cause damage on the enamel surface (8). The proper method to perform the resin composite removal is still inconclusive, and when performed incorrectly, can lead to irreversible damage of the enamel. The enamel damaged can increasing surface roughness, increasing the biofilm accumulation, promoting tooth darkening, imparing on smile esthetic (9).

Several methods have been described to remove the dental splints and more specifically, for the remaining resin composite on the enamel surface, including the use of multifluted tungsten and diamond burs (10). The use of violet light has been reported as an important aid for removing orthodontic adhesives from the enamel surface (11). The use of multiplier counter-angle associated with multifluted burs in the removal of remnant composite resin is known to be the most effective method for preserving the structure of healthy enamel during the removal of composite resins (12, 13). However, without using additional light, this method can still cause damage to the enamel structure, which can range from 0.05 (12), to 50 µm (14).

Due the diversity of the alternatives and the absence of a clear protocol to assist the clinician in this complex procedure, this study aimed to investigate the effect of additional illumination, with violet light presence in multiwavelength light curing unit (LCU) or the use of low-cost intraoral lanterns, associated with the use of diamond or multifluted burs in low-speed in the preservation of iatrogenic damage to the enamel during the dental splint removal. The null hypothesis was that light source and bur type would not influence the enamel damage caused after splinting removal.

2. DEVELOPMENT

2.1. Materials and methods

Development of new artificial models

Sixty sound bovine incisors with similar dimensions were selected, cleaned and stored in distilled water at 5ºC temperature. A wax model (Wilson, Polidental Indústria e Comércio Ltda, Cotia, Brazil) was created simulating the anterior maxilla region with four alveoli. Fifteen impressions were made from the wax model using vinyl polyvinylsiloxane impression material (Aerojet, São Paulo, Brazil). After 24 h the mandible was removed, leaving its impression in the polyvinylsiloxane mold and the maxillary anatomy was reproduced in polystyrene resin (Aerojet, São Paulo, Brazil). The enamel buccal surface of the bovine teeth was sequentially ground on wet #600, #1000, #1200 and #1500-grit silicon carbide abrasive papers (Norton, Campinas, SP, Brazil) to achieve a flat surface. Then, the teeth were polished with polishing cloths (Stuers, Erkrat, Germany) with 6µm, 3µm, 1µm, 1/4µm diamond pastes (Arotec, Cotia, SP, Brazil). Fifteen maxillary models were produced, and these collected teeth, were inserted into the artificial alveoli, simulating a clinical situation of four upper incisors (Figure 1).

Dental Splinting

The buccal surface of the bovine enamel was etched for 30 s with 37% phosphoric acid (Condac 37%, FGM Produtos Odontológicos, Joinville, SC, Brazil), rinsed with water for 30 s and dried for 30s. The adhesive system (Ambar, FGM) was activelly applied for 10 s and light activated for 10 s using a VALO Cordless multi-spectrum LED LCU (Ultradent, South Jordan, UT, USA) at the standard mode with irradiance of 1400 mW/cm^2. A high fluorescent conventional nanoparticulate resin composite (Vittra APS, FGM) was applied in 1.0 mm increments over etched surfaces and the nylon splint (Mazzafero, Diadema, SP, Brazil) were placed over the unpolymerized resin and then light-cured for 40 s with the same LCU. A final layer of 1.0 mm resin composite were applied over the fishing line and light activated for 40s on each tooth.

Splint removal - Experimental Groups

To conduct the splint removal, the resin composite over the nylon line was removed with a diamond bur (#3083, Angelus Prima Dental, Londrina, PR, Brazil) accoupled on high-speed handpiece (KaVo, Biberach, Germany) with conventional light. To remove the 1.0mm remnant resin composite, three lighting methods were used with two different rotatory instruments determining the foolowed experimental groups:

Va-DB group, use of a multiwave LED LCU (VALO Cordless, Ultradent), in its standard mode with black lens-coupled, associated with a diamond bur #3083 (Angelus Prima Dental);

Va-MLB group, the VALO LCU associated with a multifluted 118L bur (Angelus Prima Dental);

Fl-DB group, the low-cost violet light spectrum LED clinical flashlight (American Orthodontics, Sheboygan, WI, USA), associated with a diamond bur;

Fl-MLB group, using the flashlight with violet light associated with a multifluted bur;

CT-DB group, using conventional white light associated a diamond bur;

CT-MB group, using conventional white light associated a multifluted bur;

The experimental design of the study is outlined in Figure 2. The designation of the two rotary instruments was made in the split-mouth model. The lighting method was randomly assigned through a randomization website (www.random.com), generating 5 models with 2 teeth, resulting in n = 10 teeth per experimental group.

Scanning and quantitative analysis of enamel surface change

An optical three-dimensional scan was used (Arti s600 ARTI; Zirkonzahn, Gais, Italy) after application of scanning spray, to digitize all tooth surfaces. The s600 scanner is a fully automated optical stripe light scanner with a large measuring field. All scans were performed by one user according to the manufacturer's instructions. The Cumulus software (Regents of the University of Minnesota) was used to align the baseline and post-treatment models by minimizing the root-mean square differences between enamel surfaces (15, 16).

The root-mean square values are used to verify deviation between the superimposed models. Thus, a low root-mean square value is related to a high accuracy and precision (17).

The global alignment was initially used between the baseline and post-treatment digital models for the target tooth. The final alignment was done by selecting regions as reference areas that were assumed as identical and not worn (Figure 3). The good alignment of the baseline and post-treatment models were ensured by means of the number of matched points.

The mean and maximum damage enamel depth values were tested for normal distribution (Shapiro-Wilk) and equality of variances (Levene test). Data were analyzed by using two-way ANOVA followed by Tukey test using level of significance of $\alpha = 0.05$. All statistical analyses were performed using Sigma Plot 12.0 (Stata Corp, College Station, TX).

2.2. Results

The mean and maximum values for the enamel damage depth (µm) at the buccal surfaces are shown in Table I. Two-way ANOVA showed significant difference for maximum depth between the groups ($P = 0.015$). There is a significant interaction between rotatory instrument and lighting ($P = 0.027$). Tukey test showed that depth defects were significantly smaller in the groups that used violet lighting when compared to the groups that used conventional white light, irrespective of violet source. No statistical difference was found between the low-cost violet flashlight and VALO Cordless (P = ???). When no additional violet lighting was used, the diamond bur presented higher damage depth. However, when using additional violet light, the diamond bur and multifluted bur presented similar results.

3. DISCUSSION

The present study showed that the use of different violet light sources and bur types for removing the resin composite/nylon flexible splints resulted in different enamel defect depths. Therefore, the hypothesis of this study was rejected.

The fluorescence-aided identification technique is a good alternative for resin composite remnant removal and a time-saving procedure (18, 19, 20). However, at the author’s knowledge, no study has yet tested the effect of different violet light sources and burs type for removing dental splints. Similar performance of flashlight and the VALO Cordless LED was observed in the present study. This finding can be explained due to a similar violet wavelength emitted by these light sources, between 380-420 nm spectrum. The violet light has been widely associated to be helpful for resin composite removal (21). The flashlight used in this study has a low-cost compared to VALO Cordless LCU, and this can be interesting for the general clinician, while the use of VALO Cordless for detecting fluorescent particles in resin composites, requires the acquisition of an accessory lens to be coupled at the LCU tip, which might not be common in the general clinical office. This accessory lens has the purpose to act as a filter from the VALO light curing unit, decreasing the high wavelength to a 405 nm violet spectrum (18, 23). The flashlight can be easily implemented in the daily practice for dental splint removal, bracket debonding cleaning, intraoral examinations and general restorative procedures (24). However it is important highlight that when using fluorescence-aided technique, it is important to follow the safety instructions of the LED manufacturer and to use adequate eye protection such as safety glasses with filter lenses to avoid hazard effects of blue-violet and ultraviolet light (22).

The multifluted burs for orthodontic adhesive or resin composite remnant removal is been widely used (11, 19, 20). The use of this multifluted bur has been related to cause less damage to enamel (9). However, the diamond burs are common on clinical daily practice and its use for residual resin composite removal has already been discussed as a clinical alternative (25). However, when using diamond bur in high-speed hand-pieces can cause irreversible damages on enamel surface (9). However, the literature regarding the removal of composite resin using low-speed is unfortunately scarce. The present study showed that diamond and multifluted burs, when associated with additional violet lighting, present similar mean and maximum depths on enamel surface, reaffirming the importance of the fluorescence-aided technique when removing bonded materials that are near to dental structures. Our study also presented lower mean and maximum depths when using multifluted bur compared to other studies (19, 20), and this might be related to the higher number of blades in the rotary instrument (18-blade multifluted bur), while 6 or 9 bladed burs were used in previous studies (19, 20).

Recent studies using intra-oral scanners founded smaller enamel defects when using violet light associated with multifluted burs (19, 20). Although intra-oral scanners are known to be an excellent alternative nowadays, recent studies showed that laboratory scanners have better performance, presenting higher precision when compared to intra-oral scanners, resulting in STL files with minor distortions (26, 27). The STL file format is native to the stereolithography CAD software created by 3D systems and is important for superposition of the baseline and post-operative files, then lower distortion and more reliable results are expected. The Cumulus software used for the superposition of the STL files in this study is widely used to evaluate tooth surface changes caused by polymerization shrinkage or volume loss, with a recognized precision level (15, 16).

In this study, the multifluted burs caused lower damage even without the additional violet lighting use. That is an important finding, since the violet light source is still uncommon on dental office. Nowadays, even with the fluorescence of different brands and shades of resin composites varying significantly, the majority of the composites (> 80%) available should be easily detected when illuminated with fluorescence-inducing diagnostic light of proper wavelength (27). The use of violet light compared with the conventional technique, is fater and safter for resin composite removal (23). However, it is important for the clinician that the use of diamond bur in a low-speed handpiece associated with an external violet light source is different from the high-speed handpieces with violet light integrated, since there are no low-speed micromotors or handpieces with integrated FIT commercially available (23). These high-speed devices if used with diamond bur, might cause permanent damage to the enamel structure due to his high rotation (9).

The fluorescence-aided technique performed in this study with two different violet lights and rotatory instruments, showed to be helpful in diminish damage on dental structures. However, the diamond bur in low-speed must be performed with additional violet light. By highlighting the composite resin, the procedure becomes safer and less invasive. The multifluted carbide burs in low-speed presented similar results with and without the violet lights, however, since the resin composite remnant removal is a sensitive procedure and technique dependent, additional light devices should be recommended for both rotatory instruments, decreasing the procedure time, and possible risks of damage to dental enamel.

4. CONCLUSION

Within the limitations of the study design the following conclusion can be draw:

- Violet lighting during splint removal resulted in lower enamel damage when compared to conventional lightining;
- Both VALO Cordless and the low-cost flashlight presented similar decreasing on the enamel damage;
- The diamond bur use at low-speed can result in similar enamel depth as multifluted burs when using with additional violet light. However, its use without additional violet light can be harmful and invasive to the dental structures.

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TABLES

Table 1. Mean and maximum depth (µm) of enamel surface after splint removal.

Lighting	**Mean Depth**		**Maximum Depth**	
	Tungsten-carbide burs	Diamond Bur	Tungsten-carbide burs	Diamond Bur
Flashlight	15.8 ± 6.1 Aa	17.7 ± 10.6 Aa	89.2 ± 29.2 Aa	87.9 ± 36.1 Aa
Valo	15.1 ± 7.0 Aa	18.6 ± 14.7 Aa	86.1 ± 44.5 Aa	92.2 ± 29.8 Aa
No light	14.9 ± 8.8 Aa	36.5 ± 17.5 Bb	83.9 ± 34.4 Aa	135.9 ± 32.2 Bb

Different letters mean significant difference ($P < 0.05$). Uppercase used for comparing rotatory instrument effect for each lighting type (in columns); lowercase letters used for comparing lighting type for each rotatory instrument (in rows).

FIGURES

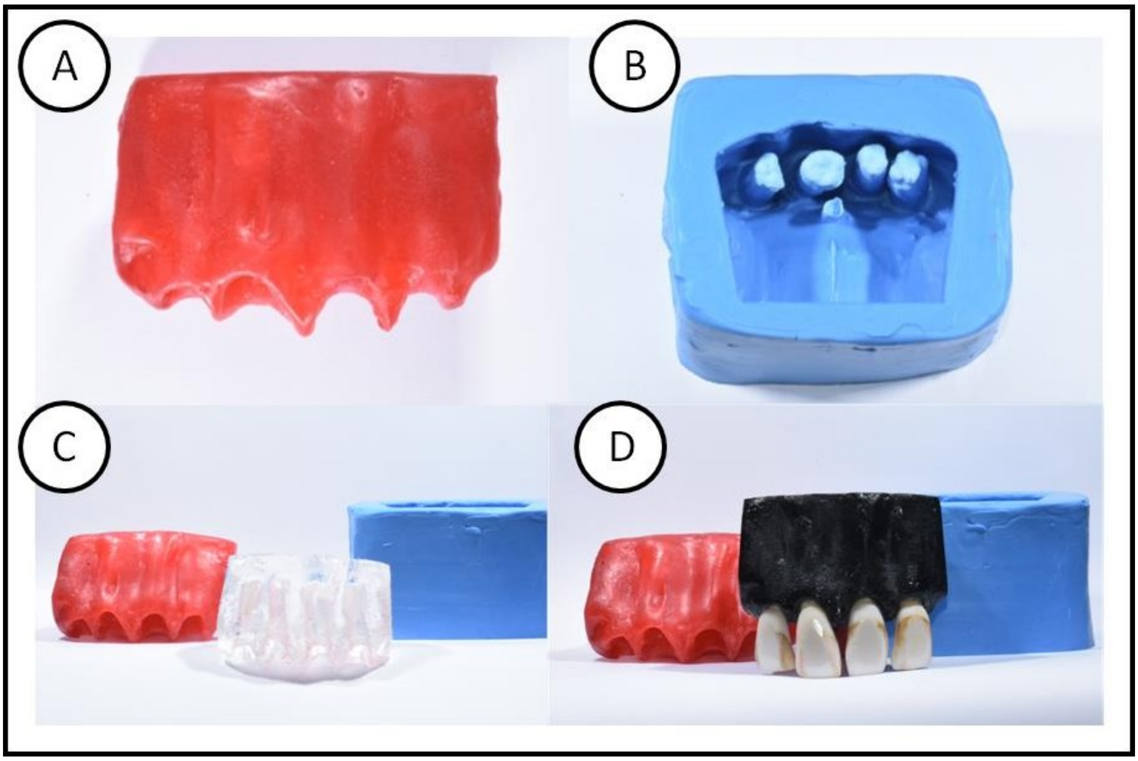

Figure 1. Fabrication of models simulating the clinical condition from teeth 12 to 22. A) Wax modeling of the maxillary structure with four alveoli; B) Impression of the wax model with polyvinylsiloxane material; C) Translucent maxillary replica in polystyrene resin after wax modelling and impression; D) Maxillary model with four teeth and painted in black color for a good scanning process, to avoid the light passing through the maxillary struture.

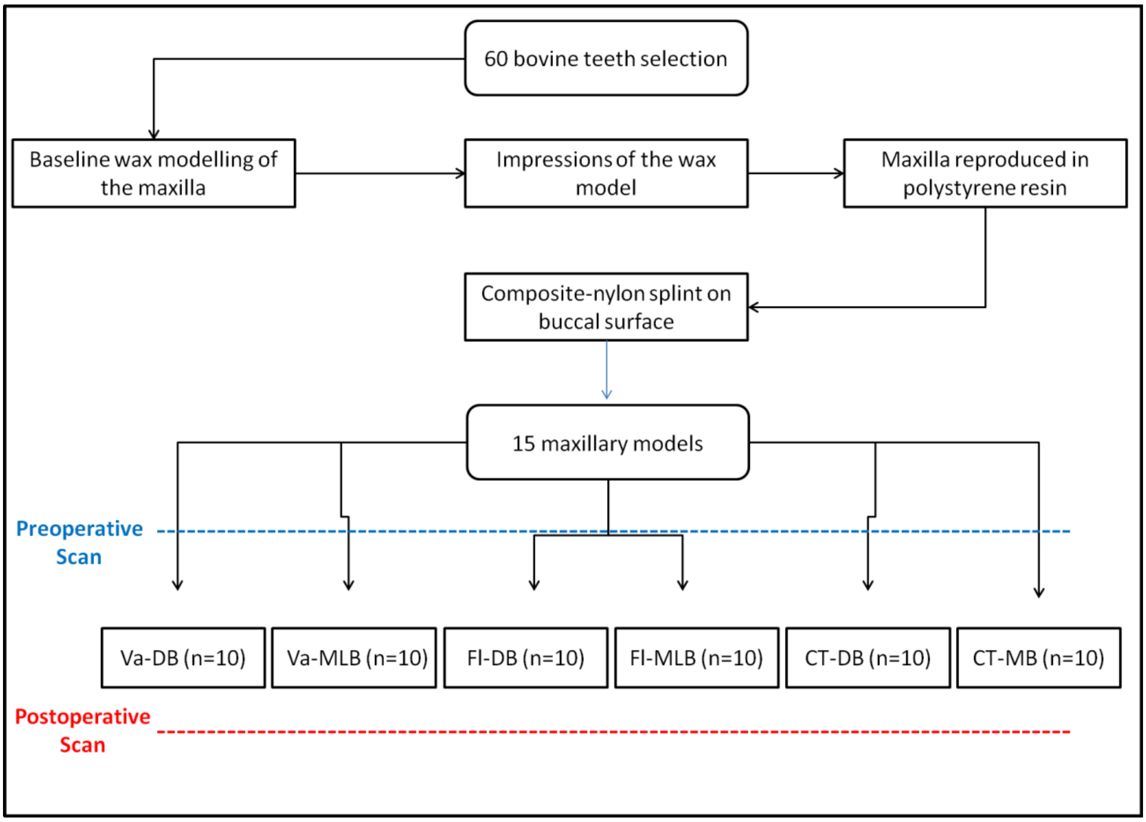

Figure 2. Study flow chart.

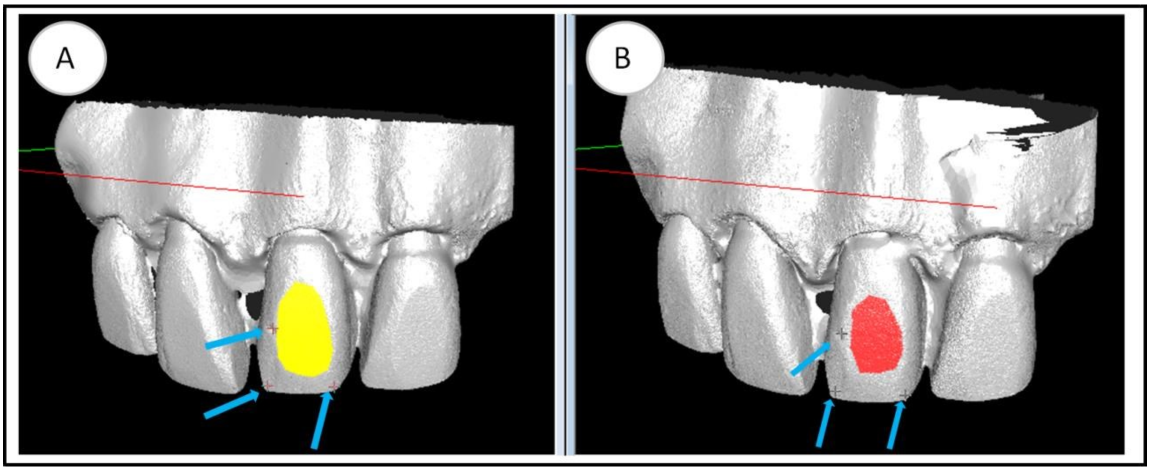

Figure 3. Digitized image of the maxilla replica. The baseline (left) and post-treatment (right) digital models were aligned by using Cumulus software (Regents of the University of Minnesota, Minneapolis). The reference regions are on the buccal surface of the tooth as show in the blue arrows.