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ORIGINAL ARTICLE

Gravimetric analysis of removed tooth structure associated with different preparation designs

Afnan F. Al-Fouzan *

Department of Prosthodontics, King Saud University, Riyadh, Saudi Arabia

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KEYWORDS

Tooth structure;
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Abstract *Purpose:* To gravimetrically analyze the tooth reduction associated with different commonly used preparation designs in relation to coronal and radical parts of the tooth.
Materials and methods: Eighty extracted permanent human teeth (four different morphologies) were divided into eight groups according to tooth type and preparation design. Each specimen underwent a pre- and post-preparation gravimetric analysis. The mass of the tooth that was removed was analyzed. Descriptive statistics were used to compare the reduction in tooth mass by weight percent. Student's *t*-test was used to compare the mean percentages of tooth reduction with a significance level of $P < .05$.
Results: Significant differences in tooth reduction were noted between different types of crown coverage preparations. Complete-coverage (all-ceramic crown) preparations for mandibular first premolars required the greatest tooth reduction (40.01%). The least tooth reduction was associated with maxillary central incisors undergoing a ceramic veneer preparation (20.19%).
Conclusion: Tooth preparations for all-ceramic crowns require greater tooth reduction relative to ceramic veneers and onlays.

1. Introduction

In a contemporary dental practice, prosthodontists can replace missing tooth structures or missing teeth with single crowns or fixed partial dentures (FPDs). A fundamental principle of restorative dentistry is the restoration of function and esthetics with minimal biological risk. Less-invasive procedures are associated with a lower incidence of endodontic complications. Partial-coverage restorations are reportedly associated with a decreased loss of pulp vitality compared with complete-coverage restorations. Data on the loss of vitality are limited in clinical studies on veneer restorations. Peumans et al. reported 2.3% loss of vitality for teeth with ceramic veneers in a 5-year clinical study.[1] Kramer and Frankenberger reported that 2% of ceramic inlays and onlays required endodontic treatment after eight years.[2] In a private setting involving 200 restorations (inlays and onlays), Otto and Denisco reported a 7% rate of endodontic-related problems at ten years.[3] Follow-up studies for single full-coverage crown restorations indicated that

* Address: Department of Prosthodontics, College of Dentistry, King Saud University, PO Box 60169, Riyadh 11545, Saudi Arabia.
E-mail address: afnan477@hotmail.com
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endodontic complication rates vary from 3% after 5 years to 5% after 8 years.[4–6] However, the rate of endodontic complications with FPD abutments is reported to range from 3–4.1% after 5 years to 21% after 6 years.[7–9]

Although many clinicians believe that partial-coverage preparation designs are much less invasive than full-coverage crowns, there is insufficient evidence in the literature supporting these ideas. An extensive search of the relevant literature revealed few published studies[10–14] related to the quantification of tooth mass that is removed during preparation but no of them quantified both the coronal and radical portions of the tooth after teeth preparation only. Therefore, the aim of this study was to gravimetrically quantify the tooth reduction associated with different tooth preparation designs in relation to coronal and radical parts of the tooth. The null hypothesis was that there is no difference in the tooth reduction between partial and complete veneer preparations.

2. Materials and methods

This study examined eighty extracted human teeth that met the following inclusion criteria: no visible defects, no restorations, no caries, and no enamel malformations. Gross scaling was performed to remove calculus deposits and soft tissue from the selected teeth using an ultrasonic scaler (Sirona L, Sirona, Bensheim Germany). Teeth were stored in a saline solution (0.9% sodium chloride) at room temperature from the time of extraction until the experiment to prevent desiccation.

The specimens were divided into four groups according to the type of tooth: maxillary central incisors, mandibular central incisors, mandibular first premolars, and maxillary first molars. Teeth were randomly distributed to the preparation groups (eight groups), randomization was done with 80 opaque containers, (20 containers for each tooth morphology), distributed randomly by blinded participant into two subgroups (crown or veneer, crown or onlay) for each tooth morphology.

2.1. Pre-preparation gravimetrical measurement

An analytical scale (Mettler Toledo-PR503, Greifensee, Switzerland) was used in this study to measure the weight of the teeth before they were prepared.

As was described by Hussain et al., teeth were blotted for 10 minutes on absorbent paper towels before the analysis to produce consistent mass measurements. Teeth were subsequently rehydrated before the preparation.[13]

2.2. Specimen preparation

Each specimen was aligned vertically in a polyvinyl chloride (PVC) tube with an external diameter of 34 mm and a height of 40 mm. The specimens were then embedded in dental plaster (SHERAALBASTER, Sher Werkstoff Technologie Gmbh Co, Lemford, Germany) 2 mm apical to the cementoenamel junction (CEJ). A dental surveyor (The J. M. NEY Company, Yucapia CA, USA) was used to position the long axis of the anatomical crown parallel to the tube.

When possible, the tooth preparations were controlled with a transparent template (0.020″, Buffalo Dental Manufacturing Co., Ontario, Canada) and a scaled periodontal probe (Williams SE Perio PROBE, Hu-Friedy Chicago, USA).

2.3. Template preparation

Four reference points were made on the top of the tube next to the line angles of the tooth to guide the placement of the template during the tooth preparation phase. These points were made from acrylic resin (Bosworth Trim Plus, Temporary Resin Acrylic, Bosworth Company, Skokie, USA).

Impressions for each tooth were made using irreversible hydrocolloid impression material (Jeltrate Dustless, Dentsply Intl, Milford, USA), and the impressions were filled by using a type IV dental stone (Royal Rock; Talladium, Valencia, USA) according to the manufacturer's instructions. All of the casts were trimmed (Handler Trimmer, Handler Manufacturing, New Jersey, USA) and perforated with two perforations around the tooth with a thin acrylic bur. A transparent template (0.020″, Buffalo, Ontario, Canada) was constructed for each tooth with a vacuum former (Easy-Vac, 3A MEDES, Gyeonggi-do, Korea). All of the casts (with the templates) were removed by using a precision low-speed saw (Isomet, Buehler, Ill., Lake Bluff, Illinois, USA) to retrieve the templates (Fig. 1).

2.4. Tooth preparations

All of the teeth were prepared by one clinician according to the suggested guidelines for standardized preparation designs (Table 1).[11,12] The tooth preparations were performed by using diamond rotary instruments at high speed. A list of the diamond rotary instruments used for each preparation design is listed in Table 2 (Fig. 2).

The preparations were then refined, all sharp internal line angles were removed, the pulpal and gingival floors were smoothed, and the walls were finished with fine diamond burs at 40,000 rpm. All preparations were performed with copious water irrigation (Fig. 3).

After the teeth were prepared, teeth were carefully removed from the PVC by using an ultrasonic scaler (Sirona L, Sirona, Bensheim Germany) to remove the plaster from the teeth.

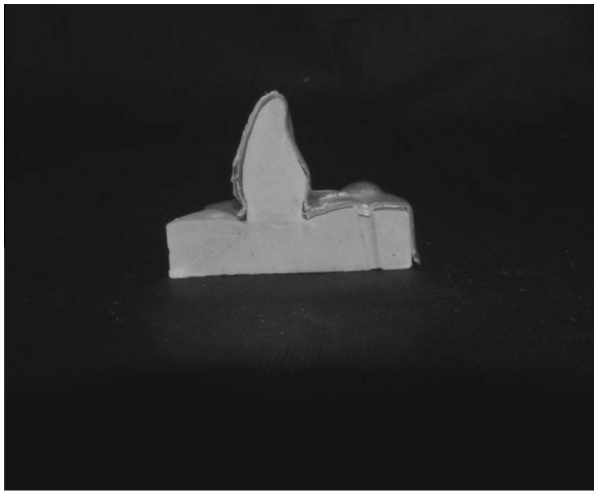

Figure 1 Sectioned cast with a transparent template.