Archives of Oral Biology 70 (2016) 111–116

Contents lists available at ScienceDirect

Archives of Oral Biology

journal homepage: www.elsevier.com/locate/aob

Effect of full crown preparation on pulpal blood flow in man

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ARTICLE INFO

Article history:
Received 2 March 2016
Received in revised form 19 May 2016
Accepted 6 June 2016

Keywords:
Tooth preparation
Pulpal circulation
Laser-Doppler flowmetry
Fixed prostheses

ABSTRACT

Objective: To determine if full crown preparation causes an increase in pulpal blood flow (PBF), indicating inflammation, in human subjects.
Design: The experiments were carried out on 35 intact, mandibular posterior teeth in 13 subjects: 32 were abutments for 16 fixed bridges that replaced first molars; the other 3 were first premolars adjacent to abutment teeth that served as un-operated controls. Crown preparations were made using an air-rotor with water-spray under regional block anaesthesia (4% articaine with epinephrine 1:100,000). PBF was recorded with a laser Doppler flow meter (LDF) before and after administering the anaesthetic, with the LDF probe on the buccal enamel. PBF was then recorded from the abutment teeth with the probe on buccal dentine after preparing the buccal surfaces of both teeth, after completing the crown preparations, and after 1 and 7 days. PBF was also recorded from the buccal enamel of the control teeth on each occasion.
Results: The mean ± S.D. PBF values before and after anaesthesia were 2.63 ± 2.13 and 2.42 ± 2.38P.U. respectively, which were not significantly different (Paired *t*-test). The mean values for the abutment teeth after buccal preparation, after complete crown preparation, and after 1 and 7 days were 5.20 ± 2.49, 4.53 ± 2.52, 4.92 ± 2.98 and 5.48 ± 2.65P.U. respectively. The 4 values for each tooth were not significantly different (two-way RM ANOVA). In the control group, the values under all six conditions were not significantly different.
Conclusions: Regional block anaesthesia produced no change in PBF, nor did full-crown preparation, neither immediately after the procedure nor 1 and 7 days later.

1. Introduction

It has been shown that the pulps of between 15% and 25% of teeth prepared for full coverage crowns become necrotic (Bergenholtz, 1991; Bergenholtz & Nyman, 1984; Cheung, Lai, & Ng, 2005). This procedure reduces tooth substance more extensively than those required for other types of restoration. Injury to the dental pulp may be caused by many factors such as heat, if water spray coolant is inadequate, and pressure applied to the dentine, particularly when dentine is removed close to the pulp.

Earlier studies had shown that heat generated while cutting the dentine was a major cause of injury to the pulp. Langeland and Langeland (1965) obtained histological evidence that crown preparation in human teeth produced no initial pulpal reaction as long as it was carried out with adequate water spray, but if the water spray was insufficient, the dentine showed evidence of burning, and odontoblast cell bodies were displaced into the ends of the cut dentinal tubules. Also, Stanley and Swerdlow (1960) showed that the pressure applied to the dentine during drilling was a factor that determined the amount of damage caused to the pulp, even when the water spray was adequate.

Kim, Dorscher-Kim, and Baek (1996) investigated the effect of drilling dentine on pulpal blood flow (PBF). Their experiments were carried out in dogs using an invasive technique in which blood flow is estimated by injecting radio-labelled microspheres into the circulation and counting the numbers trapped in the pulpal capillaries. They found that, with a water spray, drilling dentine caused a reduction in PBF of around 13% from the baseline, resting value. Without water spray, the corresponding value was a

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http://dx.doi.org/10.1016/j.archoralbio.2016.06.005
0003-9969/

34% fall, and it fell to 89% below baseline one hour after the preparation.

The laser Doppler technique was first used to monitor PBF in human teeth by Gazelius, Olgart, Edwall, and Edwall (1986). Unlike the labelled microsphere method, it is non-invasive and provides a continuous record, although it cannot be calibrated in absolute units of volume of blood per unit time per volume of tissue (Matthews & Vongsavan, 1993).

The aim of the present experiments was to use a laser Doppler flow meter to determine if a full crown preparation produced any changes in PBF in the treated tooth in human subjects. An increase in PBF would indicate pulpal inflammation; and a decrease, might lead to pulpal necrosis. Any effect on PBF of the initial anaesthetisation of the teeth was also investigated.

2. Materials and methods

2.1. Subjects and teeth

Observations were made on 35 teeth in 13 subjects (age: 20–30 years, mean 23.5). All the subjects had lost the mandibular first molar on one or both sides that was to be replaced with a fixed bridge. Recordings of PBF were made from 32 teeth (16, second premolars and 16, second molars) that formed the abutments for 16 fixed bridges, and from 3, first premolars adjacent to abutment teeth that served as un-operated controls. All the teeth were healthy and had completely formed roots, as determined by clinical and radiographic examination. The abutment teeth were intact and had no periodontal disease. The ratio of the crown height to the root length of the abutments was at least 1:1.5. The study was approved by the Human Experimentation Committee, Faculty of Dentistry, Chiang Mai University (Certificate no. 39/2015), and complied with the principles of the Declaration of Helsinki. The experiment procedures were clearly explained to each subject and informed consent was obtained. The privacy rights of the subjects were respected at all times.

2.2. Outline of experiments

In each experiment, before the crown preparations began, PBF was recorded from the two abutment teeth, and also from the un-operated, ipsilateral first premolar in 3 cases. Recordings were made before and 5 min after the local anaesthetic (LA) was injected. For these recordings, the tip of the laser Doppler probe was placed on the surface of the buccal enamel. The buccal surfaces of both abutment teeth were then prepared and PBF recordings were made with the probe on the exposed buccal dentine. These recordings were repeated after completing the crown preparations, and after 1 and 7 days. PBF was also recorded from the buccal enamel of the control teeth at the same stages of the preparation of the abutment teeth. Each subject was asked whether they had any pain or other symptoms associated with the fitting of the bridge at each follow-up visit.

2.3. Pulpal blood flow recording

Pulpal blood flow was recorded with a Moor Type MBF3D/42 blood flow monitor (Moor Instruments, Axminster, UK). During recording, opaque black rubber dam (Four D Rubber Co. Ltd., Heanor, UK) was applied around the crowns of the teeth in order to reduce the blood flow signals picked up from tissues outside the tooth (Soo-ampon, Vongsavan, Soo-ampon, Chuckpaiwong, & Matthews, 2003). The probe of the instrument (o.d. 1.5 mm) was supported on the tooth with an opaque stent. The stent was constructed from self-curing acrylic resin on a plaster model of the mandibular teeth of one side. It extended from the canine to the second molar and covered the buccal, occlusal and lingual surfaces of these teeth. Holes to fit the probe were drilled through the stent 2 mm from the gingival margin and perpendicular to the enamel surface. This ensured that the probe was replaced in the same position throughout the experiment, in contact with either the enamel or dentine surface (Fig. 1A & B).

The sensitivity of the laser Doppler flow meter was standardised as described by the manufacturers, and recordings were made with an upper bandwidth setting of 14.9 kHz and a time constant of 0.1 s. Blood flow was measured in arbitrary perfusion units (P.U.) (Vongsavan & Matthews, 1993a). Both the flux and DC level (backscattered light intensity) signals from the blood flow monitor were digitised by a CED micro1401-3 data acquisition unit, with the Spike II Program (Cambridge Electronic Design Limited, Cambridge, UK) and stored on a laptop computer for further analysis.

After each experiment, records were made from a stationary reflector (white card) at different light intensities. These data were used for calculating the offset of the flux signal that would have been present while recording from the teeth due to noise in the detection system (Vongsavan & Matthews, 1993b). For each flux record, the average value over 5 s was calculated and the offset due to noise subtracted from it, to obtain a figure representing blood flow in P.U. For each stage of the experiment, the mean and S.D. of the blood flow values recorded from all the teeth were calculated.

2.4. Abutment preparation and restoration

All the abutment teeth were prepared for full coverage crowns by the same operator. The crowns were of the porcelain fused to

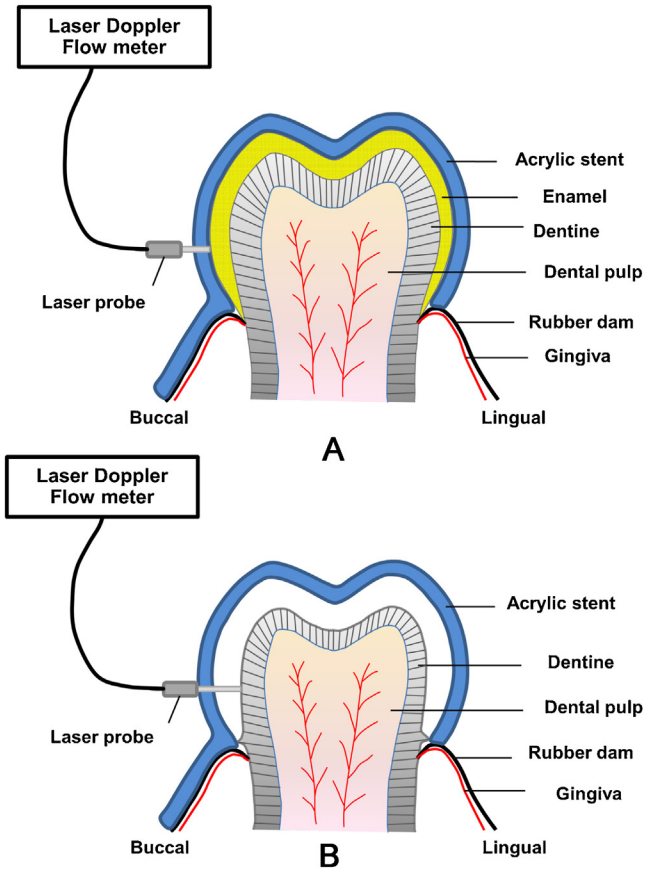

Fig. 1. Diagram of the experimental set up. (A) Pulpal blood flow recording on the enamel surface. (B) Pulpal blood flow recording on the exposed dentine surface.