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Original article

Evaluation of participants' perception and taste thresholds with a zirconia palatal plate

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ABSTRACT

Purpose: Zirconia and cobalt-chromium can withstand a similar degree of loading. Therefore, using a zirconia base for removable dentures could allow the thickness of the palatal area to be reduced similarly to metal base dentures. We hypothesized that zirconia palatal plate for removable dentures provides a high level of participants' perception without influencing taste thresholds. The purpose of this study was to evaluate the participants' perception and taste thresholds of zirconia palatal plate.

Methods: Palatal plates fabricated using acrylic resin, zirconia, and cobalt-chromium alloy were inserted into healthy individuals. Taste thresholds were investigated using the whole-mouth gustatory test, and participants' perception was evaluated using the 100-mm visual analog scale to assess the ease of pronunciation, ease of swallowing, sensation of temperature, metallic taste, sensation of foreign body, subjective sensory about weight, adhesiveness of chewing gum, and general satisfaction.

Results: For the taste thresholds, no significant differences were noted in sweet, salty, sour, bitter, or umami tastes among participants wearing no plate, or the resin, zirconia, and metal plates. Speech was easier and foreign body sensation was lower with the zirconia plate than with the resin plate. Evaluation of the adhesiveness of chewing gum showed that chewing gum does not readily adhere to the zirconia plate in comparison with the metal plate. The comprehensive participants' perception of the zirconia plate was evaluated as being superior to the resin plate.

Conclusions: A zirconia palatal plate provides a high level of participants' perception without influencing taste thresholds.

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1. Introduction

Conventional ceramics have been used for fixed prostheses; however, because the flexural strength and fracture toughness of ceramics were low [1], ceramics were frequently used in combination with metal copings. Recently, high-strength ceramics such as zirconia have been applied clinically with the advance of computer-aided design/computer-aided manufacturing (CAD/CAM) techniques. Zirconia has excellent mechanical characteristics and stability, along with a lack of water absorbency or dissolution, and can therefore be used for fixed prostheses without the need for metal copings [2].

Metal base removable dentures are usually selected to improve participants' perception and to increase patient satisfaction in place of resin base removable dentures. Because metal base removable dentures have greater mechanical strength than resin base removable dentures, the thickness of the palatal area can be decreased, leading to a reduction in the sensation of foreign body for the patient. Furthermore, because the thermal conductivity of metals is greater than acrylic resin, denture wearers can readily sense the temperature of food or drinks. It has been reported that a thicker palatal plate, such as that resulting from a resin base, increases taste thresholds [3]. However, it has also been reported that removable dentures do not interfere with taste [4]. Therefore, the influence of dentures on taste thresholds has not yet been clarified.

Although metal base removable dentures contribute to greater patient satisfaction than resin base removable dentures, the cobalt-chromium alloy frequently used in metal base removable dentures has been reported to induce metal allergies in some patients [5,6], and a similar problem has also been reported with titanium [7,8]. For patients allergic to denture-base metals, and patients who are hesitant about the use of metals in the mouth, an alternative to metal base removable dentures is required.

We hypothesized that zirconia palatal plate for removable dentures provides a high level of participants' perception without influencing taste thresholds. The purpose of this study was to evaluate the wearing satisfaction of zirconia palatal plate for removable dentures by comparing the participants' perception and taste thresholds of a zirconia palatal plate with resin or metal palatal plates.

2. Materials and methods

Sixteen healthy, fully dentate participants (10 males and six females; mean age: 23 ± 2 years), without obvious malocclusion, taste disorders, or speech disorders, were enrolled in this study. Informed consent was obtained from all participants. The experimental protocol was approved by the Ethics Committee of Tokyo Dental College (#407).

Three types of palatal plate were fabricated: (a) a 1.5-mm-thick acrylic resin (Acron MC No. 18, GC Corporation, Tokyo, Japan) plate (RP); (b) a 0.5-mm-thick Ce-TZP/ Al_2O_3 nanocomposite (P-Nano ZR, Panasonic Healthcare Co., Ltd., Tokyo, Japan) plate (ZP); and (c) a 0.5-mm-thick cobalt-chromium alloy (Wironium, BEGO, Bremen, Germany) plate (MP). Final

impression was taken by silicone rubber impression material (Fusion II, GC Co., Ltd., Tokyo, Japan) with individual tray. Three types of palatal plate were fabricated from one working cast of each participant. The RP was fabricated by wax-up on the working cast, investing, and microwave-polymerization of the acrylic resin. The ZP was fabricated using CAD/CAM (C-Pro System, Panasonic Healthcare Co., Ltd., Tokyo, Japan). The MP was fabricated by production of a refractory cast and wax-up, investing, and casting. The posterior border was set on the vibrating line (Fig. 1).

The participants were instructed to refrain from eating, drinking (alcohol or caffeine), taking medication, and exercising within 2 h prior to the commencement of the experiments.

An assistant, blinded to the aim of this study and type of palatal plates, used a random number table to select the order of palatal plate. Participants were asked to wear an eye mask while the experimenter inserted the palatal plate in participants' mouth, so that the type of palatal plate inserted could not be recognized. Each palatal plate was carefully inserted into the oral cavity to avoid touching the teeth of the participant. All examinations were carried out after the good stabilization of the palatal plate in participant's mouth was confirmed. Thirty minutes after the plate was inserted, we confirmed that the participant did not feel nauseous, and we then initiated the experiments. The participants wore the palatal plate for the duration of the following evaluations and all palatal plates were maintained in their mouth with good stability.

2.1. Evaluation of taste thresholds

The taste test solutions used were as follows: sucrose, sodium chloride, tartaric acid, quinine hydrochloride, and a mixed solution of glutamic and inosinic acids for sweet, salty, sour, bitter, and umami tastes, respectively. The test solutions were produced according to the method proposed by Yamauchi et al., and 13 solutions with differing concentrations were produced (Table 1) [9].

The taste thresholds were investigated using the whole-mouth gustatory test while wearing no plate (NP), and wearing the RP, ZP, and MP. A pipette was used to dispense 1 mL of solution into the oral cavity, and the solution was swallowed. Each participant was asked to report if they could detect the taste, and then to describe the quality of the taste. Distilled water was sprayed into the oral cavity before another taste was tested and the participant confirmed that it was tasteless. The concentration of each taste was gradually increased from the most dilute (C1). The lowest concentration at which the participant declared the presence of the taste was set as the detection threshold, and the lowest concentration at which the participant correctly reported the quality of the taste was set as the recognition threshold. The time required for completion of evaluation of the taste thresholds was approximately 10 min per palatal plate.

2.2. Evaluation of participants' perception

The evaluated items were as follows: ease of pronunciation, ease of swallowing, sensation of temperature, metallic taste,

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