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# Pressure dynamics in the trays caused by differences of the various impression materials and thickness of the relief in the maxillary edentulous model

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ABSTRACT

*Purpose:* The purpose of this study is to compare the pressure dynamics in the trays caused by differences in the various impression materials and in the thickness of the relief provided for the trays.

*Methods:* In this study, two types of polyvinylsiloxane elastomers, one type of polyether elastomer and one type of alginate impression material were used. Pressure sensors were embedded at eight locations in a model of an edentulous maxilla, and used a simulation model covered with a pseudomucosa. For each impression material, the measurement was performed five times for each of the three types of trays, and the mean values were determined. Statistical analysis was carried out using one-way analysis of variance and the Tukey's HDS method, and the various pressure sensor values for each of the impression materials were compared 10 s and 20 s after the start of the measurement. Additionally, we compared differences among the three types of trays after 20 s.

*Results:* The pressure values for sensors placed in the relief region tended to become uniform. Furthermore, we saw a tendency for the pressure to increase at the alveolar crests of the first molars on the left and right and at the posterior border of the palate, all of which support the denture, when relief was provided.

*Conclusions:* The above results suggest that making the final impression for the denture using the selective pressure technique, with consideration given to the pressure dynamic, may lead to a good outcome in terms of preservation of the alveolar ridge.



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## 1. Introduction

When making denture impressions, factors that are reported to govern impression pressure include the impression material (viscoelasticity characteristics), the tray seating speed, the tray holding pressure, and the contour of the tray [1–8]. When making impressions for alveolar ridges in an edentulous jaw, the objective is the alveolar mucosa, and the displaceability of the mucosa can vary depending on the site [9–16]. When making impressions for an edentulous jaw, taking the displaceability into consideration can determine the outcome of the denture. An inappropriate distribution of the functional pressure of the denture can cause pain, inflammation and other problems with the mucosa under the denture base, and can eventually lead to resorption of the jaw bone. Taking the displaceability into consideration when making impressions can result in the appropriate functional pressure being applied to the mucosa under the denture base when the denture is finished [17].

Impressions of an edentulous jaw can be made using the non-pressure impression technique, the pressure impression technique, or the selective pressure impression technique [18–27]. With the selective pressure technique, if the displaceability of the alveolar ridge mucosa that bears the functional pressure from the denture is not uniform, the optimum functional pressure distribution can be achieved by using the nonpressure impression technique and providing relief for thinner or thicker parts of the mucosa and openings to nerves and blood vessels, and by using the pressure impression technique for sites that can withstand functional pressure, thus contributing to the stability of the denture when functioning. According to Hyde et al. [25], dentures prepared using the selective pressure technique have a tendency to be more satisfactory than those prepared using conventional techniques. Weng et al. [26] describe the selective pressure technique as the best method for making impressions, while Rupal et al. [27] described it as the method of making impressions that has continued to be the best accepted.

Relief is defined as ''the reduction or elimination of undesirable pressure or force from a specific region under a denture base'' [28]. The main aims are to protect the mucosa under the denture base and to prevent the occurrence of pain, denture instability, denture fracture, and nerve and blood vessel compression. Another objective of relief is to provide space in the tray that will be filled with the impression material. In previous reports, it has been pointed out that providing relief can result in a uniform distribution of pressure in that particular area [29].

To date, there have been a number of reports involving impression pressure for alveolar ridges in edentulous jaws [2–4,7,8,29–31]. However, there are no reports investigating impression pressure using edentulous jaw models that simulate displaceability. Moreover, we have not found any reports investigating the pressure dynamics when making impressions using various types of materials that are used nowadays in clinical settings. As stated earlier, it is thought that the alveolar ridge mucosa is displaceable, and the pressure generated in the tray when making an impression may affect the morphology of the impression surface after the impression has hardened [2,7,31]. As a result, anticipating the pressure dynamics and adjusting the pressure as necessary can be useful in establishing a technique for making impressions using the selective pressure technique for alveolar ridges in an edentulous jaw.

In the study described here, we embedded pressure sensors at eight locations in a model of an edentulous maxilla, and used a simulation model covered with a pseudomucosa, taking the thickness of the mucosa at the various locations into consideration. We then compared the pressure dynamics in the trays caused by differences in the various impression materials and in the thickness of the relief provided for the trays. The results serve as guidelines for a clinical application of the selective pressure technique, and in turn contribute to preservation of the alveolar ridges.

## 2. Materials and methods

### 2.1. *Impression materials*

In this study, two types of polyvinylsiloxane (PVS) elastomers, one type of polyether elastomer and one type of alginate impression material, which are used in impression taking for dentures and are presently commercially available, were used. Referring to reports by Kawara et al. [6], in addition to EXADENTURE (ED), we selected AFFINIS PRECIOUS light body (AF) for the other silicon dental impression material because it has the lowest storage modulus (G′; degree of stiffness) immediately after being mixed. Table 1 lists the abbreviations for the various impression materials, along with the operation times and the holding times inside the oral cavity. Mixing was carried out in accordance with instructions provided by the manufacturer.

### 2.2. *Simulation model*

For the plaster model of the edentulous maxilla, we used an existing plaster model (MAP-34, NISSIN, Kyoto). First, referring to reports on mucosa thickness by Kydd et al. [15] and Terakura et al. [16], we ground the surface of the plaster model by only the amount of the mucosa thickness. We used small pressure sensors (PS-2KC, Kyowa Electronic Instruments Co., Tokyo) with a diameter of 6 mm and a thickness of 0.6 mm, and embedded the sensors in all eight locations in the plaster model of the edentulous maxilla (Fig. 1, Table 1). Finally, for the pseudomucosa, we used a silicon-based soft denture liner (Sofreliner tough supersoft, Tokuyama Dental, Tokyo) as a liner material with long-term elasticity. Incidentally, the plaster model used for the study had different heights for the parts corresponding to the left and right first molars; the height of the alveolar ridge on the left side was lower than that on the right side.

### 2.3. *Trays*

In our study, we used autopolymer resin (Ostron, GC, Tokyo) and prepared three types of trays. A tray that would provide no relief was prepared using the conventional method (this is referred to as the No Relief tray, abbreviated NR). For the trays