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RESEARCH ARTICLE

Softening Condition of Impression Compound for Border molding of Removable Dentures

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ABSTRACT

Objectives: To prepare removable dentures, border molding using an impression compound has been employed for a long time to obtain a denture border morphology harmonized with perioral muscle movement. However, border molding using impression compound is performed following practitioner's empirical rule. The objective of this study is to clarify the optimum softening conditions of impression compound for border molding, for which we measured the pressure assumed to be loaded on impression compound during border molding.

Materials and methods: The pressure assumed to be loaded on an impression compound during border molding was measured using a tongue pressure-measuring device. Based on the measured pressure, appropriate softening conditions were investigated (softening temperature and water immersion time) for three types of impression compound: Red (Impression compound Red, Kerr, USA), green (Peri Compound, GC, Japan), and pink (Iso Compound, GC, Japan).

Results: The measured pressure was significantly different between those in the oral vestibule in the lower anterior tooth region during tugging the mouth corner, and in the gingivobuccal fold of the lower first molar during large mouth opening. Regarding the impression compound softening condition, red was deformed by all measured muscle pressures after immersion in 60°C water for 30 seconds and 65°C water for 20, 25, and 30 seconds. Green was deformed by all measured muscle pressures after immersion in 60°C water for 30 seconds, and 65°C water for 25 and 30 seconds. In contrast, pink was deformed by all measured muscle pressures after immersion in 55°C water for 25 and 30 seconds.

Conclusion: It was clarified that for border molding, muscle pressures of all regions during the functional movements can be registered using red and green softened by immersion in 60°C water for 30 seconds and pink softened by immersion for 20 seconds.

Keywords: Border molding, Functional movement, Impression compound, Tongue pressure measuring device.

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INTRODUCTION

Various impression methods were proposed for impression taking for removable denture preparation.[1-5] Of these, border molding using an impression compound has been used for a long time aiming at obtaining a denture border morphology harmonized with perioral muscle movement.[6-8] However, no selection criteria or softening conditions of various impression compounds have been specified. Therefore, border molding using an impression compound is performed following the empirical rule of practitioners. Moreover, training is necessary to learn border molding using an impression compound, and its application may take a prolonged chair-time. Thus, we considered that it is necessary to establish a simple border molding using an impression compound not affected by practitioner's experience.

However, no report mentioned the softening condition of impression compounds, and it depends on practitioner's experience in clinical practice. To perform appropriate border molding using an impression compound without influence of practitioner's experience, it is necessary to clarify the optimum impression compound softening conditions.

In this study, aiming at clarifying the optimum softening conditions of impression compound for border molding, we measured the muscle pressure assumed to be loaded on the impression compound during border molding and investigated the softening time and temperature corresponding to the pressure.

MATERIALS AND METHODS

Muscle Pressure Measurement Experiment

The subjects were 10 healthy edentulous persons with no missing tooth (5 males and 5 females, mean age: 29 ± 1.7 years), who gave consent after explanation of the objective of this study. A probe of a tongue pressure-measuring device (TPM-01, JMS, Tokyo, Japan) (Fig. 1) was placed in the region corresponding to the denture base margin and the subject performed the functional movement, during which the pressure assumed to be loaded on an impression compound during border molding was measured.

Fig. 1: The digital tongue pressure gauge and probe

Fig. 2: Attitude in muscle pressure measurement

The pressure was measured in seven regions: The mucobuccal folds of the upper and lower bilateral first molars; mouth floor of the bilateral lower first molars; and mucolabial fold of lower anterior region. In the mucobuccal folds of the upper and lower bilateral first molars and mouth floor of the bilateral lower first molars, the pressure was measured separately on the habitual and nonhabitual masticatory sides in each subject. The functional movements performed by the subjects during measurement were large mouth opening and sucking in the upper mucobuccal folds, swallowing and anterior and lateral protrusions of the tongue in the mouth floor of the lower first molars, large mouth opening, tugging of the mouth corner, sucking, and swallowing in the lower mucobuccal folds, and tugging of the mouth corner in the mucolabial fold of lower anterior region. The subjects sufficiently practiced the functional movements while holding the tongue pressure probe in the measurement regions prior to measurement. The maximum pressure loaded on the tongue pressure probe was measured during the functional movements in each measurement region (Fig. 2). The measurement was repeated 10 times with 10-minute intervals in each region in consideration of recovery of mucosal distortion and muscle fatigue. This study was performed after approval by the Ethics Committee of Tokyo Dental College (approval number 350).

In statistical analysis, the maximum pressure in each measurement region was analyzed using one-way analysis of variance followed by Bonferroni's test ($\alpha = 0.05$) using Statistical Package for the Social Sciences (IBM SPSS Statistics, IBM, NY, USA).

Softening/Pressure Experiment of Impression Compound

Softening/pressure experiments were performed using three types of impression compound: Red (Impression compound red sticks, Kerr, USA), green (Peri compound, GC, Japan), and pink (Iso compound, GC, Japan). The impression compound was molded into a columnar shape with an 8-mm diameter and 10-mm length as an experimental sample.

The experimental pressure device was prepared using acrylic resin (Tray resin, SHOFU INC, Japan) (Fig. 3). The lower plate of the experimental pressure device was given a semicircular ditch with an 8-mm diameter on which the lower half of the sample could be set.

The impression compound was immersed in warm water in a thermostatic bath. It was then taken out and set on the experimental pressure device within 5 seconds. The compound was pressed at a pressure specified based on the results of the muscle pressure measurement experiment for 15 seconds. The upper plate of the experimental pressure device was pressed using a digital force gauge (DPS-5R, Imada Co., Ltd., Aichi, Japan) fixed on an electric measurement stand (MV-100, Imada Co., Ltd., Aichi, Japan) through the tongue pressure probe. When the pressure was applied to an impression

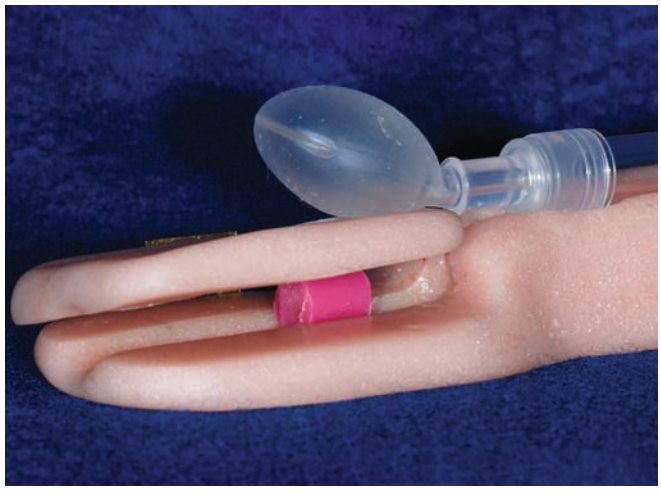


Fig. 3: Equipment for crimping

Fig. 4: The digital force gauge and digital tongue pressure gauge in pressure contact

compound, the tongue pressure probe was fixed to the upper surface of the upper plate of the device, and pressure was confirmed using the tongue pressure measuring device (Fig. 4).

After completion of pressure loading, the occurrence of deformity of the sample was recorded. The deformity was defined as contact between the upper and lower plates of the pressure device on which the sample was placed 15 seconds after initiation of pressure loading. The measurement was repeated 10 times at each pressure, and the occurrence of deformity was recorded. The softening/pressure experiments were performed in a 23 ± 2°C laboratory.

The experimental conditions were set based on the results of preliminary experiments. The water temperature for immersion and softening of impression compounds was set at 55 ± 2, 60 ± 2, and 65 ± 2°C; the water was stirred every 5 minutes to prevent biased temperature, and also the water temperature was measured. The immersion time was set at 20, 25, and 30 seconds. The pressure load was set between the maximum and minimum values on the muscle pressure measurement experiment: 2.5, 3.7, 4.0, 4.7, 7.0, and 8.1 kPa.

RESULTS

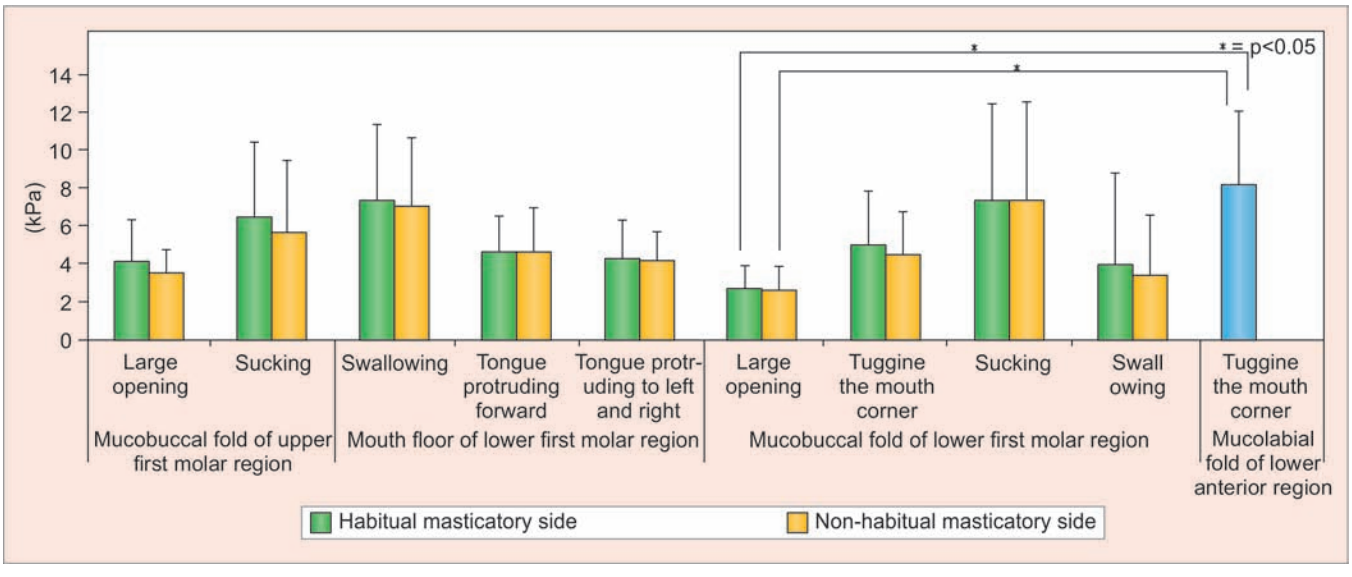
Muscle Pressure Measurement Experiment

The results of the muscle pressure measurement experiment are shown in Graph 1. The highest pressure (8.13 kPa) was measured in the mucolabial fold of lower anterior region during tugging the mouth corner, and the lowest (2.54 kPa) was measured on the nonhabitual masticatory side of the mucobuccal fold of the lower first molar region during large mouth opening.

No significant difference was noted in the muscle pressure between the habitual and nonhabitual masticatory sides.

Softening/Pressure Experiment of Impression Compound

The results of the softening/pressure experiment are shown in Table 1. Red was deformed by all pressures after immersion in 60°C water for 30 seconds and 65°C water for 20, 25, and 30 seconds. Green was deformed by all pressures after immersion in 60°C water for 30 seconds and 65°C water for 25 and 30 seconds. In contrast, pink was deformed by all pressures after immersion in 55°C water for 25 and 30 seconds, but it was already deformed before pressure loading after immersion in 60°C water for 25 and 30 seconds and 65°C water for 20, 25, and 30 seconds, showing that it was softened too much for border molding.



Graph 1: Pressure at the time of function movement

Table 1: Result of the softening-crimping experiment

Red

Time (s)	Temperture (℃) 55	60	65
20	×	×	○
25	×	×	○
30	×	○	○

Green

Time (s)	Temperture (℃) 55	60	65
20	×	×	×
25	×	×	○
30	×	○	○

Pink

Time (s)	Temperture (℃) 55	60	65
20	×	○	△
25	○	△	△
30	○	△	△

× : Not defoming
○ : Deforming
△ : Deforming before loading

DISCUSSION

Methods using an individual tray and impression compound are widely employed to take an impression for denture preparation,[9-12] in which the final impression is taken using a precise impression material with high fluidity after border molding using an impression compound and an individual tray prepared with acrylic resin. According to Petropoulos and Rashedi,[13] impression taking using an individual tray and compound is taught in 43 of 44 universities in the United States, and 28 schools use an impression compound as a border molding material. Border molding using an impression compound is recognized as a method with high educational effect because the denture border morphology is prepared by repeating the addition and removal of an impression compound while confirming and learning the relationship between the anatomical and physiological requirements of the oral regions and the outer shape of the denture border. This may be the reason why many universities incorporate border molding using an impression compound in their study curriculum.

However, impression compounds require time to learn their handling, and many general dentists may have to establish a simple border molding method to appropriately perform border molding using an impression compound.

At present, how to select one from various impression compounds corresponding to the individual targets or appropriate softening conditions has not been specified, and there are only a few reports on its characteristics.[14,15] Thus, we considered that measurement of muscle pressure assumed to be loaded on an impression compound during border molding and clarification of the optimum softening condition are useful to establish a simple border molding method.

Method of Muscle Pressure Measurement Experiment

Tsuga et al[16] reported that "the balloon probe method enables objective manometric evaluation of oral functions," and their study verified the muscle pressure measurement method using a balloon probe employed by us. This experiment was performed in healthy edentulous individuals with no missing tooth, but the oral condition is different between those who wear a denture and healthy edentulous persons, and individual variation of the muscle pressure may also be large. It may be necessary to perform a similar experiment with patients with a missing tooth and compare the results.

Method of Softening/Pressure Experiment of Impression Compound

Generally, impression compounds are softened using a burner. But, in this study, the compounds were softened by immersion in warm water in a thermostatic bath. This method is safe using no fire and useful as practitioners with little experience can safely soften impression compounds.

To specify the pressure time, the time required for border molding was measured during actual dental practice performed by five dentists as a preliminary experiment. The mean time required to insert an individual tray after softening an impression compound was 4.95 seconds, and the mean time from completion of softening using a gas burner to border molding movement and taking out the impression compound out of the mouth was 23.4 seconds, suggesting that border molding is applied in the mouth from about 5 to 20 seconds after completion of softening an impression compound. Accordingly, the pressure time was set at 15 seconds in this experiment.

Results of Muscle Pressure Measurement Experiment

The highest muscle pressure was 8.13 kPa measured in the mucolabial fold of lower anterior region while tugging the mouth corner, and the lowest was 2.54 kPa measured in the mucobuccal fold of the lower first molar on the nonhabitual masticatory side during large mouth opening. Thus, it was doubtful to use the same impression compound similarly for border molding in all regions, and we planned the softening/pressure experiment in order to confirm the deformation of the modeling compound for each pressure.

No significant difference was noted in the measured muscle pressure between the habitual and nonhabitual masticatory sides, suggesting that there was little need to distinguish the habitual and nonhabitual masticatory sides for border molding.

Softening/Pressure Experiment of Impression Compound

The softening/pressure experiment clarified the water temperature and immersion time required to soften the impression compounds by immersion in warm water for border molding. Green was deformed by all pressure loads tested, when it was immersed in 60°C water for 30 seconds and 65°C water for 25 seconds. Pink was deformed by all pressure loads when it was immersed in 55°C water for 25 seconds, 60°C water for 20 seconds, and 65°C water for 20 seconds. Red was deformed by all pressure loads when it was immersed in 60°C water for 30 seconds and 65°C water for 20 seconds. It was clarified that green and red are applicable for all functional movements after immersion in 60°C water for 30 seconds, and pink is applicable after immersion in 55°C water for 25 seconds or 60°C water for 20 seconds.

Since the lowest muscle pressure (2.54 kPa) measured on the nonhabitual masticatory side of the mucobuccal fold of the lower first molar during large mouth opening was significantly lower on the muscle pressure measurement experiment, it was doubtful to use the same impression compound similarly to these regions, but the three impression compounds tested were similarly deformed by the maximum (8.1 kPa) and minimum (2.5 kPa) pressure loads when the softening conditions were met, suggesting that, for border molding, it is more important to sufficiently soften an impression compound rather than selecting an impression compound for each region.

Simple Border Molding and Its Clinical Application

In the normal border molding procedure using an impression compound, an impression compound mounted in an individual tray is softened using a burner, immersed in water to reduce the temperature of the impression compound at the chair-side, and then placed in the mouth. In addition to the necessity of learning the handling of impression compounds, border molding using an impression compound requires many considerations within a short time (insertion of an individual tray into the mouth and instruction of the patient to perform functional movements). Thus, it may be difficult for inexperienced dentists. We designed a method in which an impression compound is mounted on an individual tray prepared on a diagnostic cast when the tray is prepared, and the tray is immersed in warm water at the chair-side to soften it for border molding. We considered that border molding becomes simple by immersing an individual tray with a mounted impression compound in warm water to soften it, followed by border molding. In addition, the safety of border molding in home dental care may be improved because no burner is used at the chair-side.

CONCLUSION

The muscle pressure assumed to be loaded on an impression compound during border molding and the optimum softening condition was investigated in healthy edentulous individuals with no missing tooth. The following were concluded:

- The highest muscle pressure assumed to be loaded on an impression compound during border molding was 8.13 kPa measured in the mucolabial fold of lower anterior region during tugging the mouth corner, and the lowest was 2.65 and 2.54 kPa measured on the habitual and nonhabitual masticatory-side mucobuccal folds of the lower first molars respectively.
- It was clarified that the impression compounds can be softened to border molding applicable softness by immersing them in warm water.

By preparing 60°C warm water and immersing green and red into the water for 30 seconds and pink for 20 seconds, border molding using these compounds was possible.

REFERENCES

1. Bolouri A, McCarthy SL. The use of pre-border-molded custom trays in complete denture fabrication. J Prosthet Dent 2001 Dec;86(6):655-657.
2. Abdel-Hakim AM, Al-Dalgan SA, Al-Bishre GM. Displacement of border tissues during final impression procedures. J Prosthet Dent 1994 Feb;71(2):133-138.
3. Solomon EG. Single stage silicone border molded closed mouth impression technique – Part II. J Indian Prosthodont Soc 2011 Sep;11(3):183-188.
4. Drago CJ. A retrospective comparison of two definitive impression techniques and their associated postinsertion adjustments in complete denture prosthodontics. J Prosthodont 2003 Sep;12(3):192-197.
5. Yarapatineni, R, Vilekar A, Kumar JP, Kumar GA, Aravind P, Kumar PA. Comparative evaluation of border molding, using two different techniques in maxillary edentulous arches – An *in vivo* study. J Int Oral Health 2013 Dec;5(6):82-87.
6. Denen HE. Impressions for full dentures. J Prosthet Dent 1952 Nov;2(6):737-745.
7. Zinner ID, Sherman H. An analysis of the development of complete denture impression techniques. J Prosthet Dent 1981 Sep;46(3):242-249.
8. Zarb, GA.; Hobkirk, J.; Eckert, S.; Jacob, R. Boucher's prosthodontic treatment for edentulous patients: Complete dentures and implant-supported prostheses, 13th ed. St Louis: Mosby; 2012. p. 161-179.
9. Mehra M, Vahidi F, Berg RW. A complete denture impression technique survey of postdoctoral prosthodontic programs in the United States. J Prosthodont 2014 Jun;23(4):320-327.

10. Carlsson GE, Ortorp A, Omar R. What is the evidence base for the efficacies of different complete denture impression procedures? A critical review. J Dent 2013 Jan;41(1):17-23.
11. Petrie CS, Walker MP, Williams K. A survey of U.S. prosthodontists and dental schools on the current materials and methods for final impressions for complete denture prosthodontics. J Prosthodont 2005 Dec;14(4):253-262.
12. Kawai Y, Murakami H, Shariati B, Klemetti E, Blomfield JV, Billette L, Lund JP, Feine JS. Do traditional techniques produce better conventional complete dentures than simplified techniques. J Dent 2005 Sep;33(8):659-668.
13. Petropoulos VC, Rashedi B. Current concepts and techniques in complete denture final impression procedures. J Prosthodont 2003 Dec;12(4):280-287.
14. Sweeney WT, John RB. American dental association specification no. 3 for dental impression compounds first revision. J Am Dent Assoc 1940 May;27(5):713-717.
15. Combe EC, Smith DC. Further studies on impression compound. Dent Pract Dent Rec 1965 Apr;15:292-294.
16. Tsuga K, Maruyama M, Yoshikawa M, Yoshida M, Akagawa Y. Manometric evaluation of oral function with a hand-held balloon probe. J Oral Rehabil 2011 Sep;38(9):680-685.