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Original article

Influence of different flask systems on tooth displacement and framework misfit in mandibular fixed implant-supported complete dentures

Conrado Reinoldes Caetano DDS, Rafael Leonardo Xediek Consani DDS, MS, PhD, Ataís Bacchi DDS, MS, Américo Bortolazzo Correr DDS, MS, PhD, Mateus Bertolini Fernandes dos Santos DDS, MS, PhD*

Piracicaba Dental School, University of Campinas, Piracicaba, SP, Brazil

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Abstract

Purpose: To evaluate the influence of different metallic flask systems for acrylic resin denture processing on tooth displacement and framework misfit of mandibular fixed implant-supported complete dentures.

Methods: Standard mandibular implant-supported complete dentures in five implants were waxed and randomly assigned to three groups: G1 – conventional flask, G2 – double flask, and G3 – occlusion flask. Framework misfit in all the implants and the linear distances between teeth (I-I – incisor-to-incisor; P-P – premolar-to-premolar; M-M – molar-to-molar; RI-RM – right-incisor-to-right-molar; and LI-LM – left-incisor-to-left-molar) were measured before and after denture processing using an optical microscope. Dentures were processed by hot water curing cycle (9 h/74 °C). Collected data were analyzed by paired Student's *t*-test and one-way ANOVA ($\alpha = 0.05$).

Results: All the measured distances presented changes in tooth displacement after denture processing. However, the M-M distance for G1 ($p = 0.003$) and the P-P ($p = 0.042$) and LI-LM ($p = 0.044$) distances for G3 showed statistically significant differences. Differences between the flask systems were not statistically significant. Statistically significant differences in the framework misfit due to denture processing were found for all the implants and groups, with the exception of right median implant for G2 and right distal implant for G3. A comparison of the flask systems found statistically significant differences in which G1 presented an increase in the misfit values and G2 and G3 a decrease.

Conclusions: Different flask systems did not cause significant changes in tooth displacement. Frameworks misfit values were influenced by the different flask systems. The conventional flask presented an increase in the framework misfit, while the experimental flasks showed a decrease.

Keywords: Acrylic resin; Passive fit; Polymerization shrinkage; Denture processing; Implant-borne prosthesis

1. Introduction

Complete dentures therapy used to be an alternative choice of treatment for edentulism. Complete denture therapy, though, has become the conventional and most prescribed treatment option for edentulous patients [1], providing improved esthetics and function, exceeding patients' expectations [2]. However, the lack of denture stability, especially for the lower prosthesis, is a key concern about conventional complete dentures [3].

Therapy with dental implants is being used on a large scale to replace missing teeth and to rehabilitate edentulous patients with overdentures and implant-supported complete dentures. Implant-supported complete dentures are among the best treatment options, because they overcome the limitations of conventional dentures, increasing stability, retention, and chewing efficiency and, thus, improving patient satisfaction [3,4].

Laboratory procedures are important factors that can influence the longevity of prosthetic rehabilitations [5]. During the manufacture of implant-supported complete dentures, obtaining a passive fit of the framework is critical, and successfully doing so depends on accurate impressions, waxing and casting done by an experienced dental technician. Without the passive fit, mechanical or biological complications can occur, resulting in peri-implant bone loss, screws loosening or fracturing, abutment, or the implant fracturing [5,6].

* Corresponding author at: Piracicaba Dental School, University of Campinas – Prosthodontics and Periodontics, Av. Limeira, 901 Piracicaba, SP 13414-903, Brazil. Tel.: +55 19 2106 5297.

E-mail address: mateusbertolini@yahoo.com.br (M.B.F. dos Santos).

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The polished surfaces and teeth of implant-supported complete dentures can be made with porcelain or acrylic resin. Acrylic resin is recommended when the patient will use a conventional upper complete denture with acrylic resin teeth or when the patient has natural dentition as antagonist. The use of porcelain teeth against acrylic or natural dentition could lead to abrasion, compromising the longevity of the treatment and decreasing the vertical dimension of occlusion [3].

Processing of acrylic resin can influence the success of implant-supported complete dentures. Polymerization shrinkage is the main limitation of acrylic resins but is an unavoidable, inherent phenomenon of this material [7], which negatively affects the dimensional stability of denture bases [8]. Several studies have evaluated the effect of polymerization shrinkage on the denture base and on the arrangement of the teeth before and after conventional complete denture processing [7,9–16]. However, several factors, such as the flask system, investment material, polymerization techniques, and cooling methods, can also influence these changes [10,15,17,18].

Changes in dentures' teeth arrangement due to laboratory processing may cause interference that induces traumatic occlusion and uneven distribution of the stresses, which could negatively affect the longevity of the implant treatments [5]. In addition, the pressure applied in the flask during the procedure could also induce warping or distortion of the framework. Maintenance of the occlusal relationship and the absence of framework distortion after acrylic resin processing must be achieved in order to provide the best treatment from the perspective of longevity.

To the best of our knowledge, no study in the literature has evaluated the influence of acrylic resin processing on the tooth displacement and passive fit of implant-supported complete dentures. Thus, the hypotheses of this study were that different metallic flask systems might influence (1) tooth displacement and (2) framework misfit during laboratory processing of mandibular fixed implant-supported complete dentures.

2. Materials and methods

2.1. Specimens

A lower cast with five analogs (an external hexagon) arranged in the anterior region between the mental foramens was used as the master cast. Impressions were made using the open-tray technique, in which the transfer abutments were splinted with low-shrinkage acrylic resin (Duralay, Dental MFG. Co., Worth, IL, USA). Thirty casts were obtained, and implant-supported complete denture frameworks waxed using cast-on UCLA abutments (Conexao Implant System, Sao Paulo, SP, Brazil) and casted with Cobalt-Chromium alloy (Star Loy C, DeguDent, Hanau, Germany). Thirty upper casts of an edentulous maxilla were also obtained to allow for the correct flasking procedures according to the experimental groups.

A standard teeth wax-up was made (Trubyte Biotone 3P/32L; Dentsply, Petropolis, RJ, Brazil) in a semi-adjustable articulator (Handy IIM; Shofu Inc., Kyoto, Japan) and replicated using a silicone matrix (Zetalabor, Zhermack, Rovigo, Italy) in all the casts. After obtaining the waxed dentures, the sets were placed on the articulator, where occlusal contacts in posterior teeth and the positioning of the incisal pin at zero, touching the incisal table, were observed.

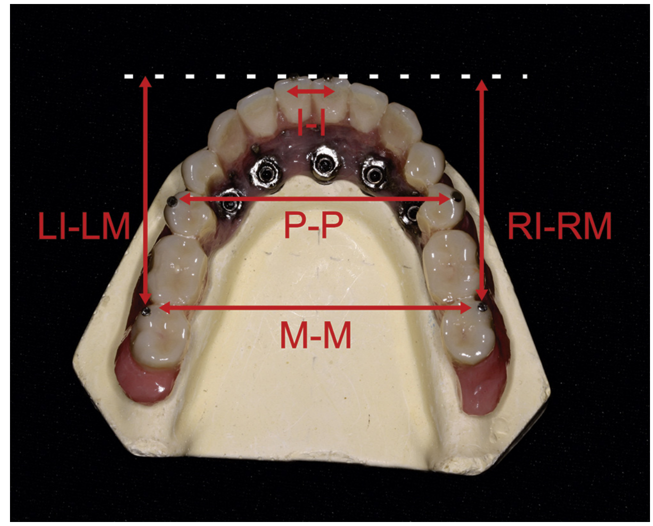

Fig. 1. Implant-supported complete denture and the measured distances.

The specimens were randomly assigned into three experimental groups according to the different metal flask system ($n = 10$): G1 – conventional flask, G2 – double flask, and G3 – occlusion flask.

2.2. Misfit assessment

To assess the misfit of the frameworks, the lower master cast was used in all the analyses involving the misfit. The vertical misfit between the abutment and the implant platform was measured in all the implants, which were divided into A (left distal implant), B (left median implant), C (medial implant), D (right median implant), and E (right distal implant) in predetermined labial and lingual sites, using a linear microscope STM (Olympus Optical Co., Tokyo, Japan) with an accuracy of 0.0005 mm. The misfit value of each component was calculated from an average of the labial and lingual misfit values.

2.3. Tooth displacement

Metal pins were placed on the teeth as reference points for measurements before and after processing the dentures. The pins were placed at the center of the incisal edge of the lower central incisors (I), lingual cusp of the lower first premolars (P), and mesiolingual cusp of the lower second molars (M). The I-I, P-P, and M-M transverse distances and the LI-LM and RI-RM anteroposterior distances were measured before and after acrylic resin processing, using the same linear microscope (Fig. 1).

To avoid possible bias, all the measurements were made in triplicate by the same operator. The differences between the measurements before and after polymerization considered the amount of movement of the teeth or framework distortion.