JOURNAL OF PROSTHODONTIC RESEARCH XXX (2016) XXX–XXX

Available online at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/jpor

Original article

Digital assessment of preliminary impression accuracy for edentulous jaws: Comparisons of 3-dimensional surfaces between study and working casts

Takashi Matsuda DDS[a], *Takaharu Goto DDS, PhD*[a,*], *Kosuke Kurahashi DDS*[a], *Toshiya Kashiwabara DDS, PhD*[a], *Megumi Watanabe DDS, PhD*[a], *Yoritoki Tomotake DDS, PhD*[b], *Kan Nagao DDS, PhD*[a], *Tetsuo Ichikawa DDS, PhD*[a]

[a] *Department of Oral and Maxillofacial Prosthodontics, Institute of Biomedical Sciences, Tokushima University Graduate School, Japan*
[b] *Oral Implant Center, Tokushima University Hospital, Japan*

ARTICLE INFO

Article history:
Received 31 July 2015
Received in revised form
17 December 2015
Accepted 24 December 2015
Available online xxx

Keywords:
Digital dentistry
Complete denture
Edentulous
Impression
Scanner

ABSTRACT

Purpose: The aim of this study was to compare 3-dimensional surfaces of study and working casts for edentulous jaws and to evaluate the accuracy of preliminary impressions with a view to the future application of digital dentistry for edentulous jaws.
Methods: Forty edentulous volunteers were serially recruited. Nine dentists took preliminary and final impressions in a routine clinical work-up. The study and working casts were digitized using a dental 3-dimensional scanner. The two surface images were superimposed through a least-square algorithm using imaging software and compared qualitatively. Furthermore, the surface of each jaw was divided into 6 sections, and the difference between the 2 images was quantitatively evaluated.
Results: Overall inspection showed that the difference around residual ridges was small and that around borders were large. The mean differences in the upper and lower jaws were 0.26 mm and 0.45 mm, respectively. The maximum values of the differences showed that the upward change mainly occurred in the anterior residual ridge, and the downward change mainly in the posterior border seal, and the labial and buccal vestibules, whereas every border of final impression was shortened in the lower jaw. The accuracy in all areas except the border, which forms the foundation, was estimated to be less than 0.25 mm.
Conclusion: Using digital technology, we here showed the overall and sectional accuracy of the preliminary impression for edentulous jaws. In our clinic, preliminary impressions have been made using an alginate material while ensuring that the requisite impression area was covered.

* *Corresponding author at*: Department of Oral and Maxillofacial Prosthodontics, Institute of Biomedical Sciences, Tokushima University Graduate School, 3-18-15 Kuramoto-cho, Tokushima 770-8504, Japan. Tel.: +81 88 633 7347; fax: +81 88 633 7461.
E-mail address: tak510@tokushima-u.ac.jp (T. Goto).
http://dx.doi.org/10.1016/j.jpor.2015.12.007
1883-1958/

1. Introduction

Impression taking is the first process in the fabrication of complete dentures and is important for achieving retention, support, and stability of complete dentures [1]. Conventionally, after the preliminary impression is taken with a ready-made tray and the study cast is fabricated, a final impression is made with a customized tray. The final impression can also be made by bite registration or using a trial wax denture as a ''bite-seating impression''.

Although impression accuracy has often been discussed for crown and bridge fabrication, there is little information on the accuracy of impressions for edentulous jaws, except in terms of the influence of various impression methods on the outline of the denture foundation [2], as the mucosa freely changes under various types of compressions while taking an impression. The quality of complete dentures fabricated using two different techniques, i.e., traditional impression involving taking a preliminary impression using a stock tray and a final impression using a customized tray, vs. and a single impression taken with a stock tray, has been compared in terms of patient satisfaction [3,4]. However, the differences in the 3-dimensional surfaces between impressions taken with these two approaches have been not investigated.

Recently, the development of a scanner has made it possible to take a tooth impression for crown and bridge fabrication, and it will soon be possible to take a direct digital impression of edentulous jaws. This scanner also allows easy measurement of 3-dimensional surfaces and quantitative evaluation.

In this study, the shapes of study and working casts were quantitatively evaluated and compared using a 3-dimentional scanner and specialized software, in order to clarify the accuracy of the preliminary impression, with a view to future taking of direct digital impressions for edentulous jaws.

2. Materials and methods

This research was conducted with the approval of the Ethics Committee of the Tokushima University Hospital (No. 1475).

Forty edentulous volunteers (35 upper jaw cases and 30 lower jaw cases; mean age: 75 ± 7 y) were investigated as subjects in this study. All of these individuals visited the Prosthodontic Department of the Tokushima University Hospital for fabrication of new complete dentures from April, 2013 to March, 2015, and for whom informed consent for participation in this study was obtained from both the patients and attending dentists. Individuals with symptoms of stomatognathic disorder, ulcers, and mucosal abnormalities were excluded. The 9 dentists attending to the 40 edentulous volunteers had clinical experience from 1 to 31 years (mean age: 39 ± 11 y), and three of them were board certified prosthodontists.

Preliminary impressions were taken using a ready-made tray and an alginate impression material (ALGINoplast EM normal, Heraeus Kulzer Japan Co., Ltd., Tokyo, Japan). Dentists were required to use requisite anatomical landmarks for complete denture fabrication: the ready-made tray could be modified slightly using wax, according to the individual dentist's judgment, and as little pressure as possible was applied while taking the impression. A study cast was fabricated according to the manufacturer's instructions, using a dental plaster (Zostone, Shimomura Gypsum Co., Ltd., Saitama, Japan). This study cast was used to make a customized acrylic tray in a conventional manner, with blockout and relief in the necessary parts and without a spacer. The final impression was made using this tray and a silicone material (Examixfine Regular, GC Co., Tokyo, Japan) after muscle trimming. A working cast was fabricated in a same way as for the study cast.

The study and working casts were digitized using a dental 3-dimensional scanner (Dental Wings 7Series, Dental Wings Inc., Montreal, Canada) so that all of the impression surface was covered. This device provides five-axis processing and a nominal resolution of ± 15 μm. The error value of the 3-dimensional scanner was determined to be within ± 15 μm by the manufacturer through the repeated measurement of the shape and superimposition. This error value was confirmed using a similar approach in our experiment. The accuracy of this scanner was thus enough to evaluate the impression accuracy of the edentulous ridge. Three-dimensional scanning was done in a constant environment: at a temperature of (25 ± 3) °C, humidity of (60 ± 10) %, and (1014 ± 10) hPa atmosphere. The scanner was calibrated with the aluminum calibration plate (125 mm × 10 mm × 100 mm, Dental Wings Inc., Montreal, Canada) according to the manufacturer's instruction. Parts other than the impression surface in the 3-dimensional images were trimmed and edited on the monitor by a single operator and a single inspector. The two surface images of the study and working casts were superimposed through a least-square algorithm using imaging software (Gom Inspect V7 SR2, GOM mbH, Braunschweig, Germany), such that the surface image of the working cast approximately matched that of the study cast with the least-square error, and were examined qualitatively on the screen.

Furthermore, the surface of each jaw was divided into six sections according to the functional significance reported by Boucher [5,6], and the differences between the two images were quantitatively evaluated for each of these areas. The six sections in each jaw were defined as shown in Fig. 1. The boundary of the sections was determined through inflection points by agreement between two examiners. A downward direction, which indicates that the surface of the working cast was settled relative to that of the study cast, was defined as ''plus''; conversely, the upward direction, which indicates that the surface of working cast was lifted relative to that of the study cast, was defined as ''minus''. The maximum values of the difference in upward and downward directions (minimum value for the downward direction), and the distribution ratio of three categories (less than the absolute difference of 0.25 mm, between 0.25 and 0.5 mm, and more than 0.5 mm) were quantitatively examined for each section.

The shape of residual ridge in each jaw was classified according to the treatment difficulty indices developed by the Japan Prosthodontic Society [7], and the differences between the two images were also evaluated for classification of residual ridge shapes.

Please cite this article in press as: Matsuda T, et al. Digital assessment of preliminary impression accuracy for edentulous jaws: Comparisons of 3-dimensional surfaces between study and working casts. J Prosthodont Res (2016), http://dx.doi.org/10.1016/j.jpor.2015.12.007