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## Technical procedure

# Duplication of complete dentures using general-purpose handheld optical scanner and 3-dimensional printer: Introduction and clinical considerations

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### ABSTRACT

**Purpose:** To introduce a new clinical procedure for fabricating duplicates of complete dentures by bite pressure impression using digital technology, and to discuss its clinical significance.

**Methods:** The denture is placed on a rotary table and the 3-dimensional form of the denture is digitized using a general-purpose handheld optical scanner. The duplicate denture is made of polylactic acid by a 3-dimensional printer using the 3-dimensional data.

**Conclusion:** This procedure has the advantages of wasting less material, employing less human power, decreasing treatment time at the chair side, lowering the rates of contamination, and being readily fabricated at the time of the treatment visit.

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## 1. Introduction

As part of serial procedures for complete denture fabrication, duplication of existing complete dentures has been an alternative fabrication technique [1]. When the patient is

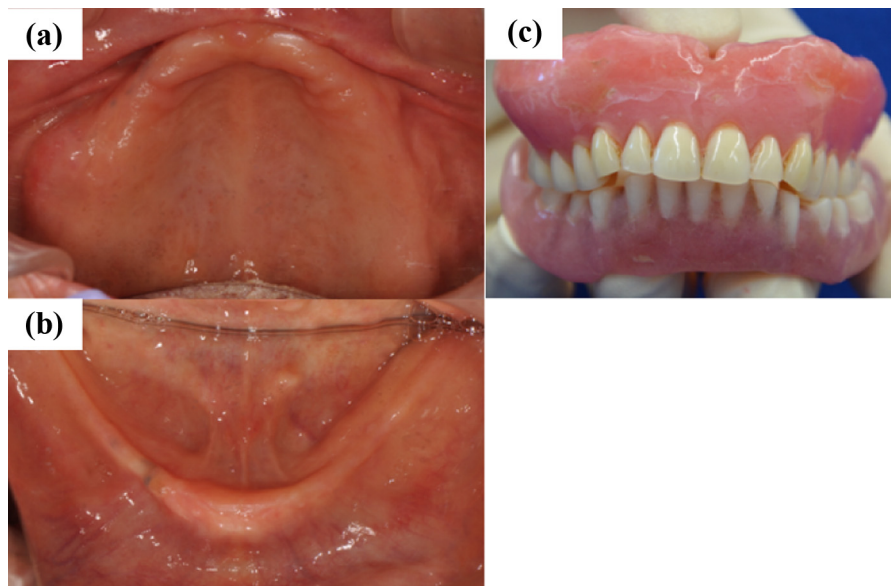
satisfied with the duplicate complete denture after the post-insertion observations and adjustments, the duplicate dentures are transferred to new complete dentures with dental laboratory work [2–5]. The main advantage of the technique is the reduction in the adaptation period to the new complete dentures, which is particularly important for elderly patients.

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**Fig. 1 – Preoperative view of oral cavity (a and b) and existing complete dentures (c).**

It is also useful in cases with severe bone resorption when the new denture form is not predictable. The duplicate dentures are occasionally used as a specialized tray of bite pressure impression, in which both final impression and interocclusal records are obtained at the same time [6].

Duplicate dentures are generally fabricated by the following procedures: flasking of the complete denture with alginate impression materials in a duplicating flask, opening it, pouring auto-polymerizing resin into the mold, trimming, and polishing [7]. Recently, the use of computer-aided design/computer-aided manufacturing (CAD/CAM) has become widely accepted in the field of dentistry [8–12]. In the field of complete denture prosthodontics, impression and interocclusal records are sent to dental laboratories, and new final dentures are commercially fabricated using CAD/CAM technologies [13–15]. However, there are few reports of the use of digital technology for duplication of complete dentures in the dental clinic setting [16].

This article introduces a clinical procedure for fabricating duplicate complete dentures using a general-purpose handheld optical scanner and a 3-dimensional (3D) printer in the dental clinic setting. The availability and advantages of this procedure are discussed with a clinical case.

## 2. Materials and methods

A 66-year-old woman with fully edentulous jaws was enrolled in this technical report (Fig. 1). The patient had the complete dentures with hard resin teeth and acrylic denture base and also had complaints concerning material degradation and complete denture instability. The existing complete dentures are improved to an appropriate form by using auto-polymerizing acrylic resin and tissue conditioner, if needed. The clinical trial was conducted with the approval of the Ethics Committee of the Tokushima University Hospital (No. 2413).

### 2.1. Digitalization of complete denture

The denture was fixed to a rotary table (Guru-ri kun Mini-AC, Sigma Planning Corporation, Tokyo, Japan) by using a mixture of utility wax and sticky wax. Before the image capturing, the denture was coated with siccarol powder (Wakodo, Tokyo, Japan) to facilitate the scanning. A handheld optical scanner (Artec spider, Artec Group, Luxembourg) was equipped at the focal point of the denture to digitize the surface topography of the denture (Fig. 2). The rotary table was rotated at a speed of 6°/s, and the denture topography was scanned every 120°. This condition was determined through the scanning performance of optical scanner and processing speed of the computer. In cases with severe undercut areas, additional regional scanning is needed by holding the scanner while detecting the area that was not scanned from the monitor of the computer. The 3D data was integrated on the computer and the 3D denture form was constructed using the specific software (Artec Studio 9, Artec Group, Luxembourg) (Fig. 3). A smoothing digital filter is applied to the raw digital data. Texture mapping digital filter was not performed because there was no need for denture color. The 3D denture form can be designed with the aid of a computer (Claytools, 3D Systems, SC, USA), if the dentist needs to improve the denture form after scanning (Fig. 4).

### 2.2. Additive manufacturing of the duplicate denture by using a general-purpose 3D printer

The duplicate denture was made of polylactic acid (PLA) using a 3D printer (Makerbot Replicator 5th Generation Model, Makerbot, NY, USA) using the 3D data of the denture form. Thereafter, the denture form—internal and external surfaces, peripheral or border of the denture base, and occlusal tables—was trimmed and finished using hand instruments (Fig. 5).

The duplicate denture was adjusted while evaluating the fit of the duplicate denture base to the basal tissues using a

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