Case Report

Measuring the retention of removable mandibular prostheses by a standardized model: A technical report

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Abstract

Three cases of mandibular implant overdentures (IODs) were measured for retention by a developed model. A nylon thread was tied through a hole at the midline of the IOD and seated it in the patient's mouth properly. Briefly, a facebow was set on the patient, with its arms firmly held by an assistant. The other end of the thread was tied into a loop, and the thread was inserted through a hole at the Camper's line of the facebow and hooked onto a portable force gauge. The thread was then pulled in parallel with the arms of the facebow by the force gauge until the prosthesis dislodged while the patient opened his mouth. Denture retention was measured five times, and the mean was calculated. Appropriate analysis for validity and reliability of the model was performed, and statistical results showed that it was valid and reliable for measuring the retention of removable mandibular prostheses.

Keywords: Clinical studies, mandibular prosthesis, retention, standardized model

INTRODUCTION

Several previous clinical studies have shown that the retention of complete maxillary dentures or base plates was measured with specially designed devices that were complex to set up and required space for equipment.[1-7] van Kampen *et al.* and Geckili *et al.* used instruments similar to universal testing machines in clinical studies.[4,8] In addition, portable and small devices have been used in other clinical studies.[9-11] The use of a portable force gauge has been validated by Fromentin *et al.* for crosshead speed, validity, and reliability;[12] however, vertical pulling (90° to the occlusal plane) is difficult to maintain

due to patient's lip and head position. Furthermore, constant crosshead speed is not possible for human operators. Moreover, these previous studies do not specify operator-dependent factors such as position of measurement or direction in which the prosthesis was dislodged. The present case aimed to report a reliable, standardized model to measure the retention of removable mandibular prostheses in clinical studies.

CASE REPORT

Three edentulous patients with mandibular implant overdenture (IOD) were evaluated for the retention of their prosthesis. They were positioned in a dental chair

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in a comfortable, upright position, with the head resting firmly on the headrest. One end of a length of nylon thread [19–20 mm × 0.5 mm; KNK; Kanagawa Co. Ltd., Kanagawa-ken, Japan, Figure 1] was tied through a hole between the two central incisors of the mandibular denture. The patient was then asked to bite down the denture to obtain proper seating and sealing of the denture. The measurement model utilized a facebow (ARCUS facebow; KaVo Dental GmbH, Biberach/Riß, Germany). The facebow was set on the patient's face with the nasal bridge for support, with the arms of the facebow firmly held by an assistant. The other end of the thread was tied into a loop, and the thread was inserted through a hole at the Camper's line of the facebow and hooked onto a portable force gauge (Lutron FG-5005; Lutron Electronic Enterprise Co. Ltd., Taipei, Taiwan). The thread was then pulled in parallel with the arms of the facebow by the force gauge until the prosthesis dislodged [Figure 2] while the patient's mouth was open as wide as possible. Then, the resultant retention was noted. Such measurement was performed five times, and the average retention was calculated.

Validation of the model

To test the validation of this method, the mandibular 2-IOD simulated by an acrylic model with a ball and clip attachment was set in a phantom head model and measured by five operators. Human operators' results were validated with a universal testing machine (5544 Tensile Tester; Instron, Norwood, MA, USA). Retention was measured using a portable force gauge; five different operators performed removal five times each, and the average values were recorded. Hand or crosshead speed was fully operator dependent. Removal was performed with the universal testing machine five times (once for each operator) with a constant crosshead speed of 240 mm/min; the setting in the phantom model was simulated because it was not possible to achieve a similar setting to that used on the phantom model with the facebow. Agreement between retention data obtained by five operators was compared with the data obtained by the universal testing machine using the Steel test with control in JMP software (version 13.0; SAS Institute, Cary, NY, USA). No significant differences were observed between the two measurements [Figure 3].

Reliability testing

This clinical study was conducted to measure retention in three patients wearing mandibular 2-IOD with ball attachments. Three different operators measured retention five times each for each patient; the average retentive forces were calculated. Reliability was analyzed
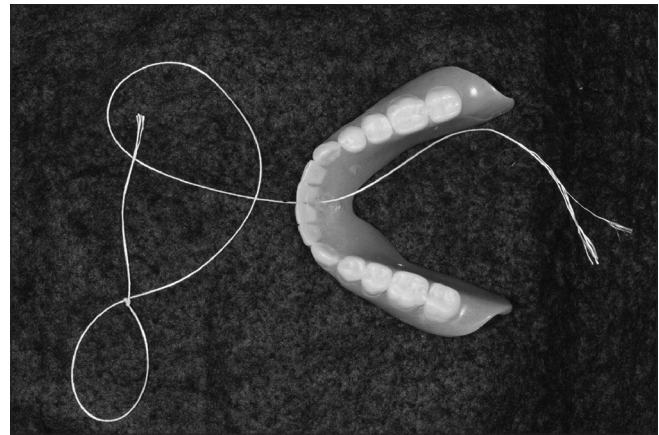

Figure 1: Mandibular complete denture with a small hole at the midline interdental papilla used to attach an end of the nylon thread
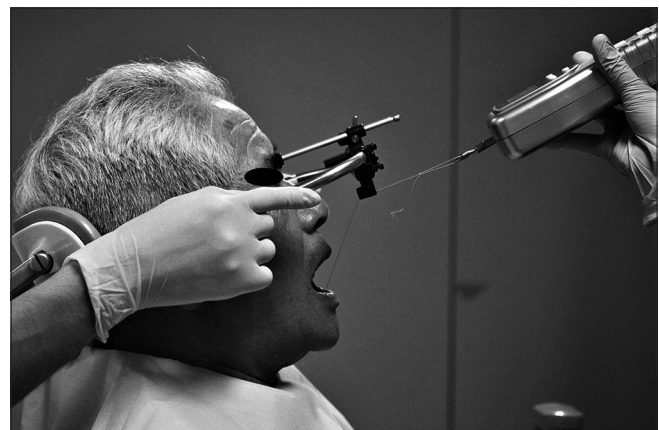

Figure 2: Standardized setting for measuring retention of the removable mandibular prosthesis. The denture is pulled out with a nylon thread by a force gauge through a facebow, pulling in parallel with the facebow arms. The facebow was positioned on the patient's face, and the facebow arms were firmly held in position by an assistant
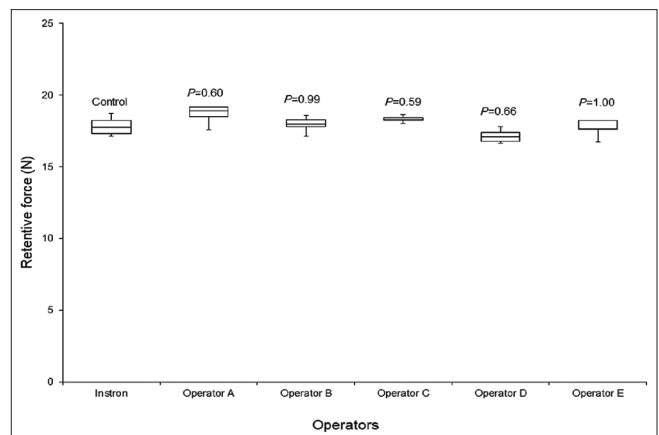

Figure 3: Box plot comparing the retentions of a two-implant overdenture acrylic model in a phantom head measured by five different operators with those obtained with a universal testing machine

using an interclass correlation coefficient (ICC) and Cronbach's alpha in IBM SPSS Statistics (version 22.0;

Table 1: Intraclass correlation coefficient values and Cronbach's alpha values for inter- and intra-class correlation coefficients for three operators' measurements of three patients (*n*=5)

	ICC
Interoperator consistency	0.804
Intraoperator consistency	0.612, 0.808, and 0.917 (α=0.920, 0.956, and 0.982)

α: Cronbach's alpha. ICC: Intraclass correlation coefficient

IBM Corp., Armonk, NY, USA) to determine inter- and intra-operator consistency. Interoperator consistency was sufficiently high in the clinical tests, with an ICC value of 0.804 [Table 1]. Intraoperator ICCs were also sufficiently high for the three operators at 0.612, 0.808, and 0.917, with Cronbach's alpha values of 0.920, 0.956, and 0.982, respectively.

DISCUSSION

There were many challenges in this model, such as range of mouth opening, variable crosshead speed in pulling the gauge (hand speed), and facebow instability when dislodging a strongly retentive denture. These factors indicated that validity and reliability should be tested for the measurement model in this case.

In this report, the crosshead speeds of force gauge generated by human operators could not be controlled to be constant among or within operators. The universal testing machine is unique in that it measures the retentive force by dislodging the denture model with constant speed; it is widely used for *in vitro* studies. To test the validity of the model, the retentions measured by human operators were compared with the values obtained with a gold standard universal testing machine. In this study, the crosshead speed of the universal testing machine was set at 240 mm/min, which is the normal speed achieved by a human operator pulling a portable force gauge.[12] The retention measurements taken by different operators using this model were comparable to those obtained with the universal testing machine.

Testing of the model under clinical conditions revealed that each operator showed reliable consistency and agreement with other operators, with ICC value of 0.8–0.9 sufficient to conclude that there was a high reliability among the operators. Intraoperator consistency, which was evaluated after each operator performed a measurement five times, showed that ICC values and Cronbach's alpha values were sufficiently high to indicate intraoperator reliability. These results demonstrated that the present method is reliable for use in clinical studies, regardless of the operator.

This report on using a facebow as a reference was considered an appropriate reference setting to overcome the weaknesses of previously used methods in clinical conditions. In this model, the nylon thread is always used to pull the denture through the facebow and is pulled in parallel with the facebow arms in all situations. That constant positioning was designed to obtain consistent retention measurements, and the use of the facebow provides standardization. The study results and statistical analyses indicated it as a reliable tool for measuring retention of removable mandibular prostheses, with consistent results between operators.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflicts of interest

There are no conflicts of interest.

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