EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org

Vol. 71, 3363:3369, October, 2025

Print ISSN 0070-9484 • Online ISSN 2090-2360

Fixed Prosthodontics and Dental Materials

Submit Date : 12-08-2025 • Accept Date : 15-09-2025 • Available online: 01-10-2025 • DOI : 10.21608/edj.2025.408534.3572

# COMPARING THE FITNESS OF REMOVABLE PARTIAL DENTURES FABRICATED USING DIFFERENT DIGITAL AND CONVENTIONAL IMPRESSIONS (IN VITRO STUDY ON THE DEGREE OF ADAPTATION OF RESTS)

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*ABSTRACT*

**Purpose:** Comparing the fitness of removable partial dentures (RPD) fabricated using different digital and conventional impressions regarding degree of rest adaptation

**Materials and methods:** Using different ways for recording impression (digital and conventional) for fabricating a simplified metallic structure of RPD devoid of clasps for a partially edentulous Class II modification 1 Kennedy classification where clinical case was simulated on a dental Reference model. The maxillary partially edentulous arch had two prosthetic spaces, one bounded saddle between two abutment teeth, right maxillary cuspid and right maxillary second molar and a distal extension base with left maxillary second bicuspid as abutment. Then evaluating the degree of fitness for rests on rest seat by recording number of perforations in silicon between rests and rest seats in different positions and measuring thickness of silicone using stereomicroscope.

**Results and conclusion:** It was concluded that the two digital impression techniques showed better results regarding the degree of adaptation of the rests. These results were not significant to the extent the to consider impression technique as a factor that influences the adaptation of occlusal and cingulum rests at different measurement points.

**KEY WORDS**: Removable partial denture, Digital impression, degree of adaptation, rest seat, reference model.

## INTRODUCTION

While digital dentistry for RPDs is rapidly advancing, a definitive statement that one method is universally "more accurate" than the other is difficult to make. We are presenting conflicting data, particularly for full-arch rehabilitations and the precise capture of soft tissue.

For removable partial dentures, where the interaction with both hard and soft tissues is critical for stability and fit, conventional impressions

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have traditionally been considered reliable due to their ability to capture functional movements and displaceable soft tissues. [1,2]

However, improvements in intraoral scanner technology, scanning strategies, and CAD/CAM fabrication processes are constantly narrowing the gap. The choice between digital and conventional impressions for RPDs often depends on the specific clinical scenario, the operator's experience and comfort with the technology, and the capabilities of the dental laboratory. Further in-vivo clinical studies are needed to provide more robust evidence on long-term clinical outcomes and RPD fitness with digital workflows. [3]

Digital impressions often face more challenges in accurately capturing mucosal areas and movable soft tissues compared to conventional impressions. This is a crucial aspect for RPDs, which rely heavily on soft tissue support. Some studies have found significantly greater vertical deviation in residual ridge morphology recorded by digital impressions compared to conventional ones. [4]

Both methods are technique-sensitive. The accuracy of conventional impressions can be influenced by factors like impression material properties, tray selection, mixing technique, and pouring errors. Digital impression accuracy depends on the intraoral scanner (IOS) system, scanning strategy, operator proficiency, and oral conditions (e.g., presence of blood or saliva). [2]

Conventional workflows involve multiple steps (impression, pouring cast, waxing, casting), each with the potential to introduce errors. Digital workflows aim to streamline this by directly creating a digital model, potentially reducing cumulative errors.

Some research indicates that RPDs fabricated using digital technologies can exhibit comparable fit accuracy in the rest region (the tooth surface where the RPD rests) with those made by conventional lost-wax techniques. However, some studies also suggest that conventional methods, particularly lost-wax casting, might show better overall fit and accuracy in certain areas. [5]

## MATERIAL AND METHODS

By impression making of a clinical case partially edentulous Class II modification 1 Kennedy classification, a simulated model was poured as a Reference model. The maxillary partially edentulous arch had two prosthetic spaces, one bounded saddle between two abutment teeth, right maxillary cuspid and right maxillary second molar and a distal extension base with left maxillary second bicuspid as abutment.

Surveying of that model was done by the aid of a Delineator (Model B2; Bioart) for defining path of insertion and preparing guiding plane. Then, the rest seats triangular in shape were made in the artificial abutment teeth of the Reference model, in the right maxillary second molar and left maxillary second bicuspid in the mesio-occlusal region where an apex facing the center of the tooth. The angles were rounded, this preparation covered 2/3 of the marginal ridge and 1/3 mesio-distal direction with 1.5 mm. depth. Cingulum rest seat was made in the cingulum region of the right maxillary cuspid, which presented a step shape with rounded angles mesio-distally with 1.5 mm. depth parallel to the long axis of the tooth.[6]

Following the proper rest seat preparations in the Reference model, different ways of impression were performed according to the experimental groups, which are divided into subgroups in

***Group (A)*** Conventional impression technique was performed using a partial aluminum stock tray and irreversible hydrocolloid (Hydrogum Alginate Type I; Zhermack), Loading of the impression material onto the tray and rest seat areas was performed, and finally the impression of the patient's area of interest of the case was then recorded. A vibrator was used to fill the mold with Type IV plaster. Once the plaster set, the cast was separated from the impression and trimmed.

***Group (B)*** Scanning of the reference model was performed by the study operator and when necessary, assisted by a trained operator using Medit intraoral scanner according to manufacturer's recommendations.

***Group (C)*** Scanning of the reference model was performed by the study operator and when necessary, assisted by a trained operator using Ranyes intraoral scanner according to manufacturer's recommendations.

Intraoral scanner started with the buccal, then occlusal, and lingual regions. The resulting Standard Tessellation Language (STL) files were then processed in Exocad software to create 3D-printed models. These models were printed in resin with 0.05mm layers, oriented at a 90° angle. Following printing, the models were cleaned with 95% alcohol in an ultrasonic cleaner for 120 seconds to remove uncured resin. They were then either left in a dark place for 30 minutes to dry or dried immediately with a compressed air gun. Finally, they underwent a post-curing process using a device that emits a (405nm) wavelength. A single operator took the impression of the models

We fabricated simplified metal frameworks for the removable partial dentures (RPD) that included only rests, major and minor connectors, and saddles. These frameworks served as the primary specimens for our research, allowing us to evaluate the adaptation of the rests on the reference model. We determined our sample size of N=5 by calculating the standard deviation from a similar study by Ichi [8]. This sample size exceeds the 80% statistical power required.

The metal frameworks for all ways of impression were made of cobalt-chromium alloy by the lost-wax technique, according to the simplified design. After the frameworks were finished and polished in the dental laboratory (Figure 2).

The rests were adapted based on the methods of previous studies [6,9]. We applied a condensation silicone impression material (Zhermack's Oranwash-L) to the rest seats of the abutment teeth and the inner surfaces of the rests. The metal framework was then positioned on the reference model along its path of insertion. We applied digital pressure until the impression material fully polymerized. The metal framework and the silicone were subsequently removed together as a single unit [6,9].

TABLE (1) Subgroups, satisfactory adaptation (%), regular adaptation (%), maladaptation (%), mean (SD), minimum and maximum value of rest adaptation (μm)

| Groups | Teeth | Satisfactory adaptation | Regular adaptation | Maladaptation | Mean (SD*) | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| A | Canine | 20% | 80% | | 325.645 (201.13) | 94.455 | 532.645 |
| | Premolar | 20% | 40% | 40% | 131.325 (13.95) | 104.324 | 163.545 |
| | Molar | 20% | 40% | 40% | 133.545 (129.14) | 106.345 | 165.755 |
| B | Canine | | 40% | 60% | 159.086 (57.32) | 102.680 | 245.805 |
| | Premolar | 60% | 40% | | 160.302 (81.32) | 73.195 | 276.435 |
| | Molar | 60% | 40% | | 161.086 (82.30) | 74.456 | 281.559 |
| C | Canine | | 40% | 60% | 156.605 (58.32) | 101.225 | 241.245 |
| | Premolar | 60% | 40% | | 159.454 (79.85) | 72.495 | 279.342 |
| | Molar | 60% | 40% | | 160.580 (80.32) | 73.125 | 280.025 |

**** SD - Standard Deviation.***

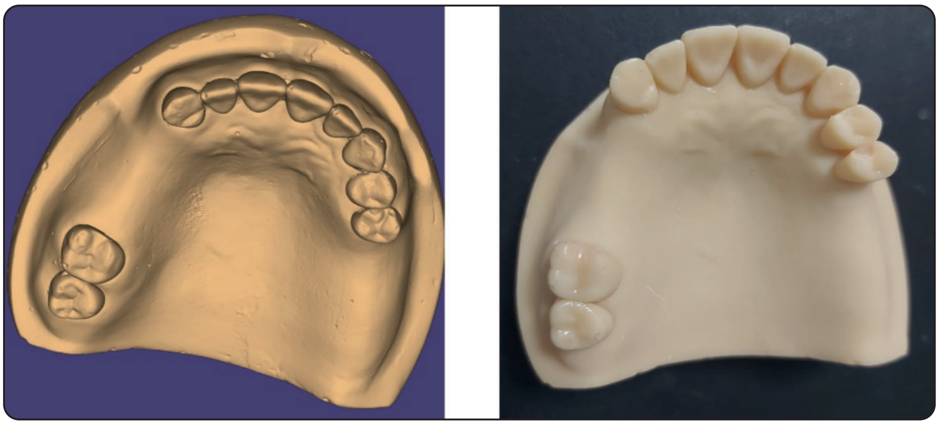

Fig. (1) 3D printed model.

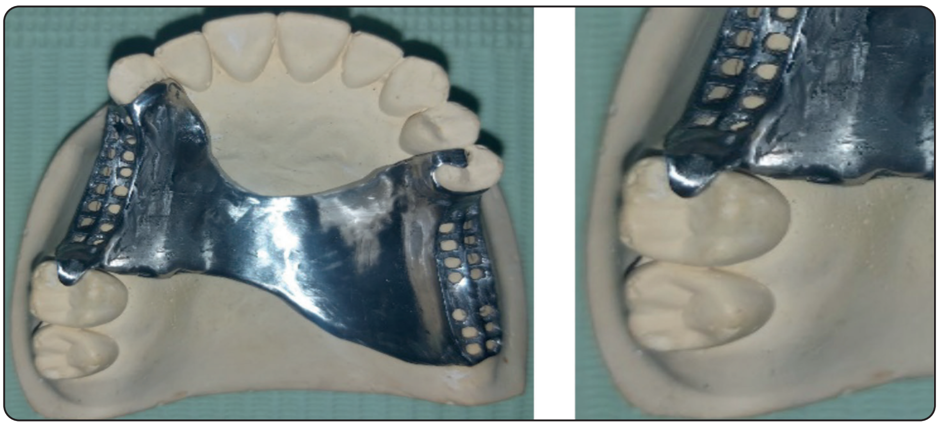

Fig. (2) Metal framework on reference model.

Silicone perforations where there is contact between rest and rest seat was an indication, while the absence of perforations represents its maladaptation. (Figure 3) Based on the stereomicroscope, A qualitative analysis [9,10] where the following criteria were used to evaluate adaptation:

***Maladaptation:*** No perforations were present.

Satisfactory adaptation: Perforation were observed on both the edge and the center of the support.

Regular adaptation: Perforation were found on either the border or the center of the support. [11].

The adaptation between the rest and the rest seat was quantitatively assessed by measuring the thickness of sectioned silicone material using a stereomicroscope. Three measuring points were used to obtain fitting values in ($\mu$m). An average of these values was then calculated for the cuspid, bicuspid, and molar abutment teeth within each subgroup. For the cuspid abutment tooth, the measurement points were at the center and on both edges of the rest. For the bicuspid and molar, the measurement points were at the mid-point of minor connector, the apex and edges. (Figure 4). The adaptation of the rest was measured under a stereomicroscope directly after the impression material setting.[6,9] A smaller gap between the rest and the rest seat meant a better degree of adaptation, while a larger gap signified poor adaptation.

Statistical analysis of the results was conducted using a 5% significance level. Quantitative data regarding rest adaptation were analyzed with a two-factor ANOVA ($p<.05$) to determine how the impression strategy and rest type affected adaptation. A one-factor ANOVA ($p<.05$) was used to compare point values of rest adaptation among different impression techniques. Qualitative data were presented using descriptive statistics. A Komolgorov-Smirnov normality test was performed beforehand, which indicated a significance level greater than 1% among the experimental groups and analyses.

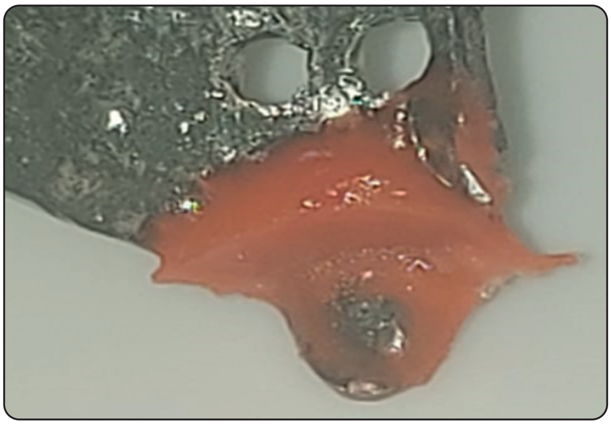

Fig. (3) Image of regular adaptation with perforation in rest edges.

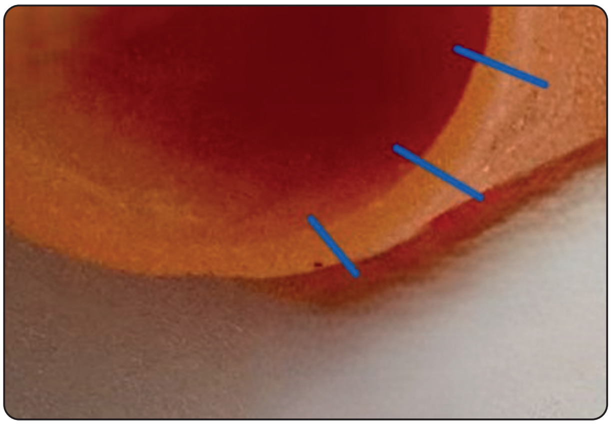

Fig. (4) Image of the measurement of the degree of rest adaptation

## RESULTS

Group A had the largest gap between the rest and rest seat on the cuspid, while groups B and C showed the most satisfactory adaptation for molars and bicuspid. Maladaptation was most prevalent in cuspid. Group A also had the lowest mean for adaptation on molars and bicuspid.

A two-factor ANOVA was used to evaluate how the way of making the impression and rest seat type affected prosthesis adaptation. The results showed no significant effect for either the way of making the impression (P value is 0.211) or the rest seat type (P value is 0.075). The interaction between the way of making the impression and abutment tooth type was also not significant (P value is 0.072). In short, these findings suggest that neither the way of making the impression nor the rest seat type had a statistically significant influence on how well the prosthesis adapted.

Regardless of the way of impression used, the quantitative and qualitative data showed no significant difference in the adaptation of the occlusal and cingulum rests.

TABLE (2) Group and mean (SD*) in $\mu$m of the measurement points of the cingulum rest adaptation

| Groups | Border (point in incisal direction) | Center | Border (Point in cervical direction) | P-valor |
|---|---|---|---|---|
| A | 365.0 (234) | 364.0 (250) | 242.5 (190.5) | |
| B | 179.0 (61.3) | 169.8 (89.5) | 129.8 (55.8) | 0.143 |
| C | 180.0 (63.2) | 171.2 (91.2) | 132.0 (57.4) | |

**** SD - Standard Deviation.***

TABLE (3) Group and mean (SD*) in $\mu$m of the measurement points of the bicuspid mesial occlusal rest adaptation

| Groups | Border (Mesial point) | Center | Border (Center point) | P-valor |
|---|---|---|---|---|
| A | 371.0 (238.0) | 365.5 (252.0) | 246.1 (190.3) | |
| B | 182.5 (63.0) | 171.5 (92.2) | 132.7 (58.4) | 0.147 |
| C | 182.9 (63.5) | 172.2 (92.8) | 133.1 (59.5) | |

**** SD - Standard Deviation.***

TABLE (4) Group and mean (SD*) in $\mu$m of the measurement points of the molar occlusal rest adaptation

| Groups | Border (Mesial point) | Center | Border (Center point) | P-valor |
|---|---|---|---|---|
| A | 112.432 (26.2) | 120.598 (26.9) | 161.456 (22.9) | |
| B | 172.775 (107.5) | 151.807 (54.9) | 159.958 (93.9) | 0.621 |
| C | 170.895 (106.8) | 150.968 (54.2) | 158.469 (92.6) | |

**** SD - Standard Deviation.***

## DISCUSSION

The difference in results likely stems from several factors, including the type of scanners used, the software, and the operator's experience. Studies have shown that different scanner systems can have significant variations in accuracy and precision, which directly affects the quality of the rapid prototyping device.

Measuring the gap between a rest and its seat with silicone may not be as accurate as using three-dimensional analysis, like optical microscopy, because of the limitations of elastomers. Despite this, it remains the most common method in studies of RPD adaptation.

Absence of clamps, small sample size, only class II Kennedy classification limited the validation of the research. Further clinical research needs to be conducted to validate the use of digital impressions in removable dentures including other Kennedy classification with larger sample numbers.

## CONCLUSION

It was concluded that digital impressions provided better adaptation of rests, resulting in smaller, clinically acceptable gaps between the rest seat and the rest.

Occlusal rests showed better adaptation than cingulum rests, a finding consistent across both digital and conventional impressions.

Despite these observations, the way of impression was not a statistically significant factor affecting the adaptation of occlusal and cingulum rests at different measurement points.

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