

Comparison of Different Techniques of Copying Dentures

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Received September 26, 2023; Revised October 27, 2023; Accepted November 02, 2023

Abstract The aim of this study was to evaluate the dimensional accuracy of three copying techniques for a master denture and recommend a suggested method for complete denture duplication. The method advocated in this study was to reproduce copies of dentures with three duplicating techniques. The first method used in this study constricted replicas of master denture using full acrylic method (A) acrylic bases and acrylic teeth. The second method replicated the master denture using acrylic baseplates and wax teeth. The last method (C) was a full wax teeth and baseplate. The master set was constructed to include measuring points which were established by grinding holes into the original complete maxillary denture. Three measuring methods were used; articulator, digital calipers and an Alma denture gauge, to investigate the dimensional accuracy of the copied dentures compared with the master denture. The results demonstrate that none of the methods accurately replicated the master denture. The highest dimensional change was observed in method B (-0.27 %). The most accurate method duplicated the master denture was method A. With the limitation of this study, it was concluded that method A (full acrylic) is suggested to be used for copying a previous successful complete denture. Method B can be used when improvements in the fitting, occlusal surfaces and the vertical dimension is required.

Keywords: copy denture, duplicate denture, replica denture, template denture, spare denture

Cite This Article: Ali S. Alzahrani, "Comparison of Different Techniques of Copying Dentures." International Journal of Dental Sciences and Research, vol. 11, no. 2 (2023): 15-20. doi: 10.12691/ijdsr-11-2-1.

1. Introduction

A copy denture is useful way of providing a replacement of previously successful dentures. Minor changes in the tooth positioning and the polished surfaces might result in numerous problems for the patients in helping them to adapt to their new dentures. [1] These problems can be solved by a duplicating technique. This technique is used for many purposes, including; copying previous successful dentures, improving fitting and occlusal surfaces and the vertical dimension while maintaining the shape. [2] The copy technique has been widely received by patients as it accurately duplicates these features. [3] In elderly patients, a copy denture is a useful technique especially in cases where a change in adaptation might be a problem. [4] Copy dentures are used to provide a spare set of dentures, replace dentures with pale appearance, old and/ or worn dentures, produce new dentures with improvements and produce temporary dentures that can be modified gradually if the patient's ability to adapt to new dentures is in doubt. [5]

Several methods of duplicating dentures are used to copy favourable aspects of old dentures design while correcting other unfavourable aspects or to copy old

dentures without any changes in cases of the need of a backup dentures. [1-8] [10,12] One of the advantages of the copy denture approach is that it reduces the number of clinical procedures. Over the years, various denture replication techniques have been developed using different materials. [13,14] Whether the techniques are related to as copy denture, duplicate denture, replica denture or template denture, their purpose is to achieve the same outcome. [1-10] [12] Numerous research projects have focused on copying dentures with different methods and materials to find out how accurately the denture can be copied. The different methods of duplicating dentures described over the past 55 years usually included acrylic resin and wax for copying dentures and agar-agar, alginate, lab putty or silicon as the flexible mold material. [1-11] In relevant literature a project was carried out to evaluate the dimensional accuracy of replica dentures made from wax and acrylic resin in silicon or irreversible hydrocolloid flexible molds. [2] It is important to mention that different measurement methods were used in each study which vary in accuracy. Other publications have focused on the ways to contain the different mold materials such as lab putty and alginate, and how the accuracy of copied dentures can be affected when using different mold containers and materials. [4,8] Davenport and Heath, employed a "soap box" as a container and proved it to be the most suitable

for the wax teeth and acrylic baseplate method. [8] However, the study did not mention how the replicas were measured. Heath and Basker, used a modified denture flask as a rigid container and proved that it was a good container for alginate molds. [4] A previous publication tried to assess how accurately the same set of complete dentures could be copied by using an acrylic resin baseplate and wax teeth method to duplicate dentures. [1] All stages of the work were compared to the master denture by returning them to a specially adapted articulator without the use of digital caliper. Nevertheless, none of the final copied dentures constructed were an accurate copy of the master denture. The outcome of this study was described as a disappointing result. Although the measurement method used in the study seemed accurate, it proved a failure in the coping technique which was used to copy the master denture. The publication concluded that further training of dental technicians could be done in this area. [1] Unfortunately, none of the previous research has achieved and agreed on a method that would provide an exact copy of the original denture. This is one of the main factors that this research will be focusing on.

The objective of this study was to evaluate the dimensional accuracy of three copying techniques for a master denture and recommend a suggested method for complete denture duplication. Three duplication methods were selected as shown in (Table.1). Three measuring methods were used (articulator, digital calipers and an Alma denture gauge) as shown in (Figure 1).

Table 1. Duplicating methods

Method	Mold
A - Dentures acrylic bases and dentine acrylic teeth.	Lab putty material supported by plastic box.
B - wax teeth and acrylic baseplate	-Lab putty material supported by plastic box to form acrylic base plate -Silicon mold supported by a plastic ring.
C - All wax replica teeth and baseplate	Silicon mold supported by a plastic ring.

2. Method and Materials

An original (master) complete maxillary denture was duplicated by the three duplicating methods. The replicas of the master denture were made from cold cure acrylic bases (C&J Rapid Repair Polymer,Chaperlin & Jacobs,Surrey, England) and cold cure dentine acrylic teeth (Medway, cold cure dentine, Medway Dental, Surrey, England). Silicone and lab putty molds were used in this technique (Figure 2). Three replicas were made for each of the three methods. The master denture was constructed with a number of referencing points from which measurements were produced (Figure 3). These were situated in positions that would provide the greatest distances on the denture to enable ease of measuring. For example a 5% change will be more easily measured across a greater distance. The dimension (A-A₁) measures the largest distance in the vertical plain. The dimensions (B, C, D - B₁, C₁, D₁) measure the greatest distances across the occlusal surface horizontally. The dimension (A- D, D₁) measures the greatest distance from the anterior aspect of

the denture to the molars. From the lateral aspect of the denture the dimensions (E, E₁, E₂ - D₂, C₂, B₂) were established as they gave a reasonable distance in the vertical plane. Likewise for the dimensions (E₄, E₅, E₆ - B₃, C₃,D₃). Finally the dimension (E₃- G) was chosen to assess the anterior aspect of the denture. The referencing points were created by drilling holes into the master complete maxillary denture with a fine rose head burr in a dental laboratory hand piece. The referencing points were positioned so that each copied denture could be measured ten times each in thirteen dimensions by digital calipers. The advantage of drilling holes is that they give more accurate measuring points as the digital calipers can return to these fixed points at any time. An Alam denture gauge was used to define denture tooth position. The replicas were then returned to the articulator to be checked with the opposing complete lower denture (Figure 1).

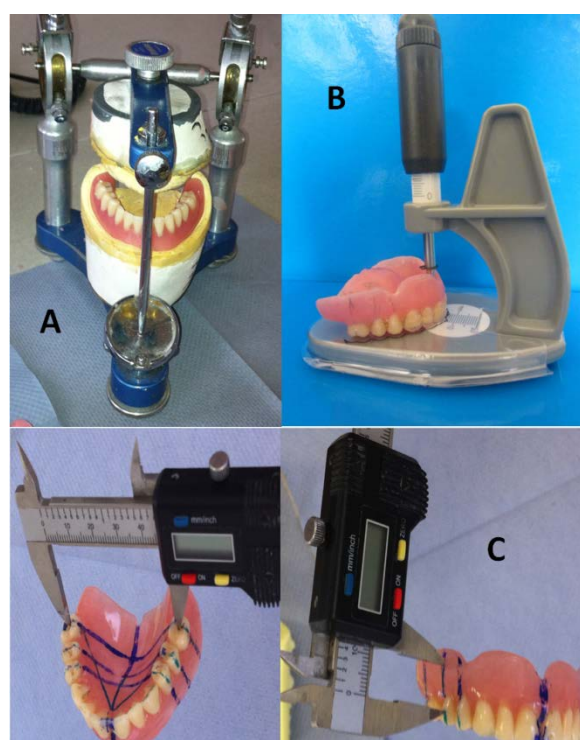


Figure 1. A- Articulator, B- An Alma denture gauge C-digital calipers

The original denture teeth were duplicated in a silicon mold (Finosil addition-curing silicon duplicating material mixing 1:1, Fino GmbH, Mangelsfeld, Germany) by using cold cured dentine acrylic teeth, to transfer all features which were made on the master denture teeth (occlusal, labial, buccal surfaces of the teeth). The same technique was used for all the copied dentures to ensure the measuring points start and end at the same fixed point. Two different mold materials were selected, lab putty for method (A) and (B) due to the rigidity of the material and a silicon mold for methods (B) and (C) (Figure 2).

In method (A) full acrylic, a plastic box slightly larger than the master denture was chosen as a container (Figure 2) into which a lab putty material was placed to record the external surfaces of the dentures. One half of the box was filled with lab putty and the denture was pressed into it until the external surfaces of the dentures were completely covered. Then the material was allowed to set and all the excess trimmed away. Petroleum jelly

(Vaseline) was used as a separating media. The second mix of lab putty was mixed and filled into the other half of the box and the fitting surface, so that the entire denture was invested and the two flat edges of the box were attached together allowing the material to set. The mold was dismantled and the denture removed by opening the mold in two halves. Finally, two holes were created in the posterior aspect of the mold to allow pouring of the acrylic.



Figure 2. A- Silicone mold B- lab putty mold

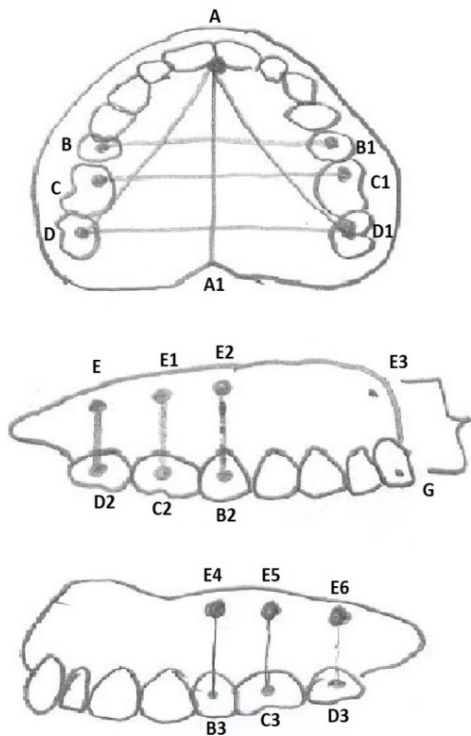


Figure 3. Diagrammatic representation of the master denture showing measuring points

Manufacturing teeth:

The monomer (C&J Rapid Repair Monomer, Chaperlin & Jacobs, Surrey, England) was flooded into the impression of the teeth in the silicon mold (Figure 4). Then tooth-colored acrylic resin polymer was poured over the monomer until the impression of the teeth was completely filled. After the tooth acrylic resin was cured, the mold was opened and the horseshoe of teeth was

removed from the mold. Any excess gingival acrylic was then trimmed away so that the necks of the teeth were level with the gingival margin. The arch was returned to the lab putty mold for method (A) to be carried out (Figure 5). Alternatively, in methods (B) and (C) the teeth were separated and trimmed (Figure 6).

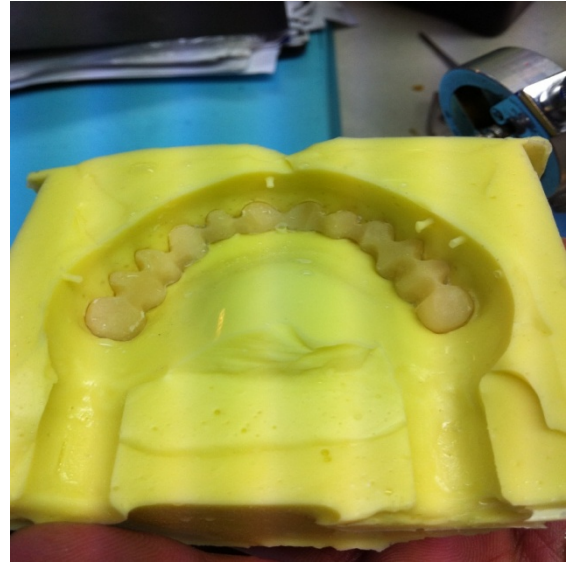


Figure 4. Horseshoe of teeth in the silicon mold after curing.



Figure 5. Horseshoe of teeth returned to the lab putty mold for method (A) before pink cold cure acrylic was poured



Figure 6. A- Master denture B- Horseshoe of teeth used for method (A) C- separated and trimmed teeth to be used for methods (B and C)

The portions of the lab putty mold were reassembled and held together with rubber bands (Figure 7) and a fluid mix of a pink cold cure acrylic was poured into one of the holes until the mold was filled to form the denture base. Then the mold was placed in a hydro flask at a pressure of 20 psi at a temperature of 40°C for 20 minutes. The mold

was opened and the replicas were removed and returned to the articulator to check the vertical dimension and the lateral movements. The same technique was applied to the rest of the copies in this method. The final copy dentures were then measured.



Figure 7. The lab putty mold portions were reassembled and held together with rubber bands

Table 2. Reproducibility of measurements made on the master denture (n=10)

Dimension	Mean (mm)	SD	CV(%)
A – A1	36.214	0.21	0.57
B – B1	36.75	0.03	0.07
C – C1	41.352	0.03	0.07
D – D1	46.941	0.03	0.06
E – D2	10.759	0.03	0.28
E1 – C2	11.849	0.03	0.25
E2 – B2	9.755	0.03	0.29
E3 – G	12.353	0.03	0.27
E4 – B3	11.255	0.03	0.34
E5 – C3	11.196	0.03	0.33
E6 – D3	9.354	0.03	0.32
A – D	33.45	0.28	0.84
A – D1	34.063	0.02	0.07

SD= standard deviation CV= coefficient of variation n= number of measurements

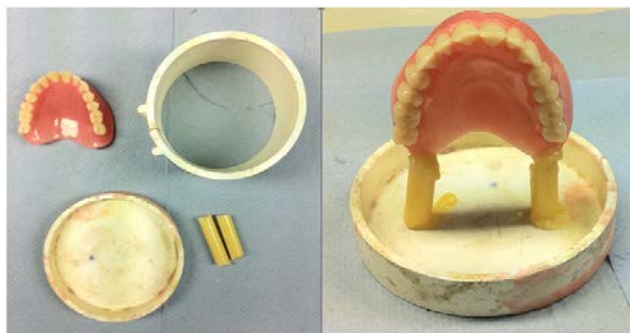


Figure 8. Pieces of sticky wax were attached to the posterior aspects of the maxillary master denture to form sprue holes in the plastic ring container

In methods (B) and (C), pieces of sticky wax were attached to the posterior aspects of the maxillary master denture to form sprue holes keeping the wax uniformly spaced from the fitting surface (Figure 8). The denture was placed in a plastic ring and then filled with silicon so that the material covered the denture up to the end of the sprues. The plastic ring container was constructed with a reference

point so that an accurate incision could be made in the silicon mold. After the silicon was set, the mold was dismantled and the denture removed by cutting the mold in two halves using a sharp knife. The portions of the mold were reassembled and returned back into the container.

Table 3. Percentage change in dimensions of three replicas made using method (A) full acrylic compared with the master denture

Measurements made on master denture	Dimension	Denture		
		1	2	3
CV (%)		(%)	(%)	(%)
0.57	A – A1	0.43	0.45	0.46
0.07	B – B1	-0.21	-0.06	-0.02
0.07	C – C1	-0.08	-0.02	-0.01
0.06	D – D1	-0.44	0	-0.54
0.28	E – D2	-0.22	-0.16	-0.15
0.25	E1 – C2	-0.33	-0.13	-0.28
0.29	E2 – B2	0	0.05	0
0.27	E3 – G	-0.02	-0.05	0
0.34	E4 – B3	-0.04	-0.10	0.07
0.33	E5 – C3	-0.06	0.06	0.14
0.32	E6 – D3	-0.04	-0.04	0.06
0.84	A – D	0.74	0.73	0.75
0.07	A – D1	-0.05	-0.01	-0.05

Table 4. Percentage change in dimensions of three replicas made using method (B) wax teeth and acrylic baseplate compared with the master denture

Measurements made on master denture	Dimension	Denture		
		1	2	3
CV (%)		(%)	(%)	(%)
0.57	A – A1	0.48	0.46	0.52
0.07	B – B1	-0.03	0.01	-0.01
0.07	C – C1	-0.01	0	0.01
0.06	D – D1	0	-0.01	-0.51
0.28	E – D2	0.09	-1.85	0
0.25	E1 – C2	-0.01	-0.17	-0.02
0.29	E2 – B2	-0.01	-0.09	-2.63
0.27	E3 – G	0.	0.02	0.1
0.34	E4 – B3	0.1	0.06	-3.11
0.33	E5 – C3	0.11	0.02	0.06
0.32	E6 – D3	-2.21	0.01	-3.16
0.84	A – D	0.76	0.77	0.12
0.07	A – D1	-0.02	-0.01	-0.72

In method (B) acrylic baseplate wax teeth, cold cure acrylic resin was mixed and poured into one of the holes in the lap putty mold to form both denture baseplate and teeth. The additional sprue allows for the air to escape. The mold was then placed in a hydro flask at a pressure of 20 psi at a temperature of 40°C for 20 minutes. After the resin was cured, the teeth were trimmed away, the acrylic baseplate was returned to the silicon mold and the molten wax was poured into the impression of the teeth. The wax was then hardened at room temperature. The mold was opened and the assemblies were removed. The wax teeth and acrylic baseplate replicas were then returned to the articulator and the wax teeth were replaced with the cold cure acrylic teeth which were produced in the silicon mold. After the replicas were cured using the common flasking and packing procedure [11] (Figure 9). The copy dentures

were returned to the articulator and adjusted if required. The final copy dentures were then measured (Table 4).



Figure 9. Flasking and packing procedure

Full wax replicas teeth and baseplate, were used for method (C). Molten wax was poured into one of the sprue holes until the silicon mold was filled. When the wax was hardened, the mold was opened and the full wax replicas were removed. The replicas were then returned to the same articulator. The wax teeth were replaced with the cold cure acrylic teeth and the replicas were then measured at this stage (Table 6) trial. After the replicas were cured using the common flasking and packing procedure. Next the copy dentures were returned to the articulator and adjusted if necessary. The final copy dentures were then measured (Table 5).

Table 5. Percentage change in dimensions of three replicas made using method (C) full wax compared with the master denture

Measurements mad on master denture	Dimension	Denture		
		1	2	3
CV (%)		(%)	(%)	(%)
0.57	A – A1	-0.17	0.5	0.46
0.07	B – B1	0	-0.04	-0.06
0.07	C – C1	0.01	-0.05	-0.01
0.06	D – D1	-0.01	-0.02	-0.01
0.28	E – D2	-0.31	-0.05	-0.1
0.25	E1 – C2	-0.06	0	-0.1
0.29	E2 – B2	-0.07	-0.11	-0.2
0.27	E3 – G	0	-0.17	-0.1
0.34	E4 – B3	0.15	-0.04	-0.03
0.33	E5 – C3	0.03	-0.01	0
0.32	E6 – D3	0	-0.01	-0.31
0.84	A – D	0.74	0.73	0.68
0.07	A – D1	-0.02	-0.04	-0.04

3. Results and Discussion

The measurements made on the master denture are shown on (Table.2). Tables three to five show the percentage dimensional changes of the copies in percentage when compared to the master denture, whereas (Table 6) show the dimensional changes of the replicas at the try in stage when the full wax (method C) was used. The results demonstrate that none of the methods accurately replicated the master denture. The highest dimensional change was observed in (method B) which was (-0.27 %). The most accurate method duplicated the master denture was method (A).

Table 6. Percentage change in dimensions of three replicas made using method (C) full wax try in stage compared with the master denture

Measurements mad on master denture	Dimension	Denture		
		1	2	3
CV (%)		(%)	(%)	(%)
0.57	A – A1	0.49	0.49	0.48
0.07	B – B1	0.01	-0.03	-0.04
0.07	C – C1	-0.01	0.01	-0.03
0.06	D – D1	-0.04	-0.03	-0.02
0.28	E – D2	-0.01	-0.06	-0.08
0.25	E1 – C2	-0.03	-0.2	-0.12
0.29	E2 – B2	-0.14	-0.19	-0.3
0.27	E3 – G	-0.04	-0.01	-0.07
0.34	E4 – B3	0.05	0.06	-0.04
0.33	E5 – C3	-0.09	-0.06	-0.15
0.32	E6 – D3	-0.01	0.04	-0.08
0.84	A – D	0.72	0.75	0.7
0.07	A – D1	-0.03	-0.05	-0.06

Table 3 list the results of method A (full acrylic) duplicating technique compared with the master denture. It can be seen that the mean percentage change in dimensions of the method A was (0.02 %), copying technique using full acrylic proved more accuracy and less dimensional changes. Table 4 demonstrate that copies made using acrylic base and wax teeth have the highest dimensional change which was (-0.27 %). The change in dimension in method B was observed to be shrinkage. Method (C) (full wax) showed a mean change in dimension of (0.03 %) as shown in (Table 5).

It can be seen from (tables. 3-5) that all duplicate dentures made by the three different methods showed shrinkage and expansion in dimensions compared to the master denture. The maximum shrinkage and expansion change observed in any dimension was (-0.54%), (-3.16%), (-0.31%) shrinkage, and (0.75%) , (3.48%) and (0.74%) for methods A, B and C sequentially. However copying the master denture using method (B) acrylic baseplate-wax teeth showed the highest change when compared with methods (A) and (C) full acrylic and full wax. These finding is in agreement with those previously reported by Polyzois, Dr. Odont and Demetriou. [2]

Finally there was a possibility that the use of wax may reduce the accuracy of the copy denture, due to the high coefficient of thermal expansion of this material. [6] In order to investigate this point, the dimensional of replicas was measured at the trial stage and after processing the final copy dentures, compared with master denture, the results are shown on (Tables 5 and 6). The mean percentage change in dimensions of the method (C) trial

stage was (0.04%) and (0.03 %) for final copies. The three replicas made by method (C) (full wax) showed shrinkage of (0.01%) in dimensions after processing.

Due to major outstanding advantages of the digital calipers, a digital caliper was chosen instead of the traditional caliper types. The measurement is read in a single step, namely, the digits can be read very fast and it can be zero-setting at any position for incremental measurements, and metric measurements are displayed to within 0.05 mm. An articulator with opposing lower complete denture was used to check occlusion, vertical dimension and lateral movements. The use of an Alma gauge was tried but rejected as a measurement technique using to the manufacturer instruction due to insufficient accuracy as a result of movement at the incisive papilla.

Method A (full acrylic) usually used for cases when a patient is satisfied with the existing dentures often request copy dentures, or patients that have recently had new dentures and are pleased with the appearance, and wish to have a spare set that look identical. [9] Copy denture used for these purposes can be constructed easily and quickly by using this method. Further development of this method is required.

Methods (B) (acrylic baseplate wax teeth), and (C) (full wax) were mainly used to reproduce previous successful dentures with improvements on fitting surfaces, occlusal surfaces and the vertical dimension while maintaining the shape. [3-5] [7,11] Preference using acrylic baseplate instead of wax baseplate for the try in stage, because it does not warp while in the mouth and it forms a rigid close fitting. [6] Kippax and Watson, tried to assess how accurately same set of complete denture can be copied by several dental laboratories. Method B acrylic baseplate-wax teeth were required to duplicate the master denture in a silicon mold. None of the final copy denture were considered an accurate copy of the master denture, concluded that dental technicians require further training in this important technique. [1]

4. Conclusion

With the limitation of this study, it was concluded that method A (full acrylic), had the highest accuracy to the

master denture and therefore it is suggested to be used for copying a previously successful complete denture. Method B (acrylic baseplate) had lowest accuracy compared to the other two methods. The accuracy of method C (full wax) was in the middle. Because in method A no improvements in the fitting, occlusal surfaces and the vertical dimension can be made since it is made of full acrylic, method B is suggested to be used for this purpose.

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