

Effect of Different Definitive Impression Techniques for Resorbed Mandibular Ridge on Retention of a Lower Complete Denture

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ABSTRACT

Aim: This study aimed to evaluate the effect of different definitive impression techniques for the resorbed mandibular ridge on the retention of lower complete dentures.

Materials and methods: Ten completely edentulous male patients with severe atrophic mandibular ridge were selected from the Prosthodontic Department's outpatient clinic, Faculty of Dentistry, Sinai University (Kantara branch). Each patient received four dentures. Dentures were divided into four groups according to the type of final impression, Group I: Conventional impression techniques (open mouth technique), Group II: Cocktail impression techniques, Group III: Modified functional impression technique, and Group IV: Wire impression technique. Each denture was used for one month and at the end of the month the retention test was carried out and the results were tabulated and statistically analyzed.

Results: There is a statistically significant difference between the groups. The results also showed that the highest mean value was in group IV, whereas the lowest mean value of retention was in group I.

Conclusion: Wire impressions produce lower dentures with higher retention, whereas conventional impressions produce lower dentures with the lowest retention, so it is considered to be more advantageous.

Clinical significance: The wire impression technique is superior in the management of resorbed ridges as compared with other techniques.

Keywords: Cocktail impression, Conventional impression, Modified functional impression, Wire impression technique.

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INTRODUCTION

Prosthodontists often struggle with an atrophic resorbed ridge while dealing with complete dentures, which results in a lack of stability and retention. In order to ensure an optimal result in the treatment of complete dentures, it is essential to identify certain mechanical, physical, and biological factors.¹

Study found that 25% of adults over 60 years of age are edentate, indicating that the number of edentate people in the United States is likely to remain stable at 9 million.² According to the Canadian Dental Association, the rate of edentulism was 6.4% in 2010, and 21.7% among adults between 60 and 79 years old. There are variations in edentulism rates between different regions within a country. Canada has a wide range of rates, ranging from 14 (Quebec) to 5% (Northwest Territories) because of factors such as fluoridated water and smoking in Brazil states with a higher standard of living and more industrialization tend to have lower rates than others.

Resorption of the residual ridge is a complex biophysical process that frequently occurs after tooth extraction.³ Following tooth loss, the rate of resorption is highest in the first year, then slows until it reaches a more gradual rate over time. All patients are affected by bone resorption, which is a chronic, progressive, and irreversible process.⁴ Nevertheless, Atwood played a crucial role in the identification of the underlying factors of residual ridge resorption, which were anatomical, prosthetic, metabolic, and functional. Based on Petrovski's findings, several factors contribute to bone loss. Inflammatory diseases and chronic diseases were identified as contributing factors, such as osteoporosis, hyperparathyroidism, diabetes, malnutrition, hormonal imbalances, and genetics. Furthermore, some local factors contributed to this

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condition, such as mechanical stress and tobacco consumption. Especially postmenopausal women and elderly women who are at risk for osteoporosis after the age of 40.⁵

Severe resorption was found in the lower than upper arch due to a smaller surface area and some additional factors including the movable floor of the mouth causing difficulty in establishing a lingual border seal.^{6–8}

An impression's accuracy, material selection, and technique all play an important role in the success of a complete denture when a patient is totally edentulous, not only for retention but also for maintaining mucosa health and overcoming the sunken appearance of the cheek.⁹

For resorbed ridges, an accurate impression is crucial to creating peripheral contours that accommodate normal muscle function and ensure peripheral adaptation without allowing air to penetrate

between the denture base and the mucous membrane to overcome dislodgment of lower denture occurs due to the muscle attachment lies more close on crest of ridge.¹⁰

Impressions can be taken in a variety of ways, including mucostatic, mucocompressive, selective, functional, and neutral zone methods.³ Among the final impression materials for a complete denture are zinc oxide and eugenol pastes, elastomeric impressions, and tissue conditioners.¹¹

Conventional impression technique (open mouth) with zinc oxide eugenol was commonly used but the main disadvantage of this technique is denture is unstable during function and rigidity of zinc oxide after setting and can't be used in case of severe undercut.¹² For these reasons, elastomer impression material and various impression techniques such as cocktail impression techniques, admixed technique, all green impression technique, and so on, were introduced.¹³⁻¹⁵ Each of these methods captures the primary and secondary load-bearing areas without distorting the residual ridge. There are several advantages to using these impression techniques: (1) They are easily controlled to gain maximum coverage; (2) They can be corrected easily; (3) They are useful for determining the extent of mucobuccal reflections; and (4) They can be used to transmit pressure toward the stress-bearing areas, such as the buccal shelf and the residual ridges in the mandible.¹⁶ In addition, Study found that functional Impression technique with the highest mean value of retention in the case of the severe atrophic ridge.¹⁷

Several modifications introduced for management of severely atrophic ridges such as a modified function impression technique and an innovative wire impression technique will be applied to ensure maximum retention and stability by creating an impression of a highly resorbed mandibular ridge using orthodontic wire to overcome several modifications to the stock tray during taking impressions in such cases.^{18,19} Despite the continuing development of impression techniques and materials, they have not been investigated; the question arises: Is the wire impression technique a future option for severely atrophic ridges? Therefore, the study will evaluate the effect of different impression techniques for the resorbed mandibular ridge on the retention of a lower complete denture.

MATERIALS AND METHODS

This research followed CONSORT 2010 and was planned as a randomized clinical trial. Ethical approval for this study was obtained from the Ethics Committee of the Faculty of Dentistry at Minia University (Committee no. 94, Decision no. 712).

Sample size was determined using the R statistical package version 3.3.1. T-test power calculations were made to determine the appropriate sample size. Sample size was calculated according to 90% power and 5% significance with identical distribution.

Ten male patients were selected for this study from the clinic of Removable Prosthodontics Department, Faculty of Dentistry, Sinai University (Kantara) according to the following criteria:

Inclusion Criteria

- Flat mandibular ridge with no or minimal undercuts at the anterior and/or the mylohyoid ridge regions, and free of sharp bony edges.
- Healthy mucosa covered the ridge without ulcerations, inflammation, or flabby hyperplastic tissue.
- Salivary flow is normal.
- The position and size of the tongue are normal.
- Angle class I maxilla-mandibular relationship.

Exclusion Criteria

- A patient who is undergoing treatment for an unstable chronic condition, such as hypothyroidism, diabetes, or cancer.
- Extremely large or extremely small edentulous arches.
- A patient has poor neuromuscular control.

Sample Distribution

Each patient received four dentures. Dentures were divided into four groups according to the type of final impression: Group I: Conventional impression techniques (open mouth technique), Group II: Cocktail impression techniques, Group III: Modified functional impression technique, and Group IV: Wire impression technique. Each denture was used for a period of one month, and at the end of the month, the retention test was carried out, and the results were tabulated and statistically analyzed.

Clinical Procedures

The primary impression was taken by using irreversible hydrocolloid alginate impression material (Cavex-Holland) in a perforated, suitable stock tray. Plaster was poured into the impression to obtain a study cast, and special trays were fabricated and verified according to the type of final impression.

In group I: The secondary mandibular impression was prepared employing conventional methods by applying zinc oxide and eugenol wash (Cavex outline BV, Holland) after the border molding was completed with green stick compound (Fig. 1).

In group II: An autopolymerizing acrylic resin is used in this technique in order to fabricate a customized tray. The posterior region of the tray contains wax spacers of 1mm and cylindrical mandibular rests of increased vertical height. It is recommended that the patient close his mouth in order for the mandibular rests to fit snugly against his maxillary alveolar ridge. It prevents the tray from moving anteroposteriorly and mediolaterally during definitive impressions. It is designed so the tongue will be able to move freely during functional movements by making the lingual surfaces concave on the mandibular rests. It is imperative that the patient run his tongue along the edge of his lips, suck his cheeks, pull in his lips, and swallow with his mouth closed, as in closed mouth impression technique, until the impression material hardens. As soon as the impression was retrieved, it was visually examined for irregularities, disinfected, and poured into a dental stone (Fig. 2).

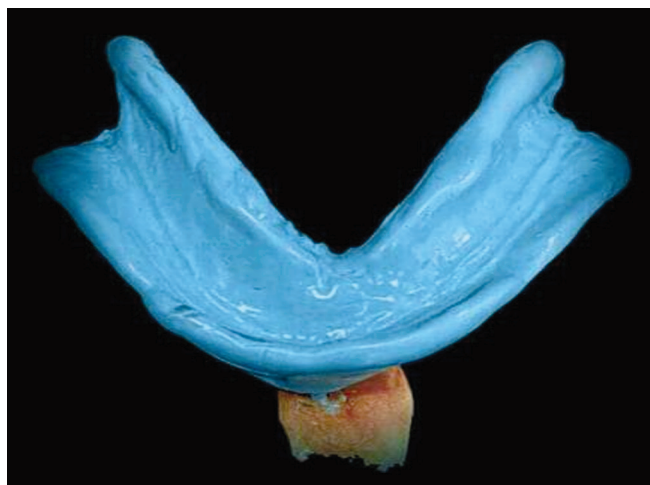


Fig. 1: Conventional secondary impression with zinc oxide eugenol

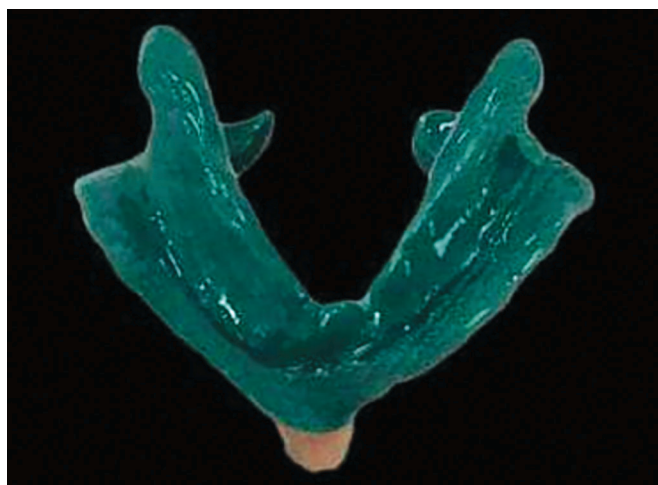


Fig. 2: Secondary impression of Cocktail technique was visually examined for irregularities and disinfected



Fig. 3: Impression of Modified functional technique was checked



Fig. 4: A special tray was created from 19-gauge wire

In group III: An L-shaped plastic stick was used as the handle on the tray (80 mm long, 8 mm in diameter). The material around the

hollow stick (acrylic resin) was molded, allowing for air suction. After that, the hollow handle was polished and finished. A 10 mm diameter acrylic resin base with a height of approximately 15 mm was attached to the individual tray at the midline of the resorbed ridge. In addition to the functional handle, a bolt with a diameter of 2 mm and a length of 11 mm was attached to the upper central hole. To allow air to pass through the custom tray for suction, two small holes were drilled in the acrylic resin base. As the custom impression tray was seated in the patient's mouth, adjustments were made based on its stability. It was necessary to disconnect the bolt from the base before molding the lower lingual border for the patient to be able to move her tongue freely during the impression process. Both sides of the acrylic resin tray were fitted with molar supports to keep them in place during this step. A suction movement was performed by the patient during the molding of the labial and buccal borders. Following this, elastomeric impression material was loaded into the tray and gently seated in the patient's mouth. In order to record the lingual and sublingual flanges, the handle is removed again once the tray is properly positioned with the material overflowing. While the patient moves his tongue for approximately 20 seconds, the resin molar supports are pressed to keep the tray in place. At the end of the procedure, the operator firmly grasps the handle of the tray and asks the patient to repeat the suction movements with the handle reattached to the tray. The impression of the modified functional technique was checked and poured with stone (Fig. 3).

In group IV: In the primary cast, a special tray was created from 19-gauge wire (SS Smith). A universal plier was used to loop the orthodontic wire and extend it from one retromolar pad to another. Handle fabrication was done with the same wire (Fig. 4). The special tray was checked intraorally. At the beginning, polyvinyl siloxane (Zetaplus, Zhermack, Italy) was mixed equally with catalyst and base. The wire was loaded with mixed impression material for a primary impression. Any deficiencies were rectified by adding putty to the deficient areas. Immediately after completing the border molding, the putty was relieved with a flame-shaped carbide bur to make room for the final impression material. An elastomeric silicone impression material with a light body consistency was used for the final impressions (Oranwash L, Zhermack, Germany) (Fig. 5). The master cast was poured with die stone (Fig. 6). Registration of jaw relationships was performed after fabrication of the record blocks, and then the try-in resulted in a denture made of heat-cured PMMA that was processed by compression molding.

Denture Retention Evaluation

The retention device, which allows applying an increasing vertical force on the denture, is composed of an attachment part, a chin rest, and a universal testing machine (Lloyd Instruments Ltd., United Kingdom). This machine provides an accurate reading for the force needed to dislodge the denture vertically. The patient was instructed to sit in an upright position and keep his chin firmly seated on chin support. The bar was rigidly connected to the denture, and the attachment part of the universal machine was adjusted. The device was subjected to a slowly increasing vertical load (10 mm/min) until the denture was totally out of place. The load at dislodgment was manifested by an audible sound tuck and confirmed by a sharp drop recorded using computer software (Nexyge-MT-4.6; Lloyd Instruments), and this value was recorded in Newton.



Fig. 5: An elastomeric silicone impression material with a light body consistency was used for the final impressions

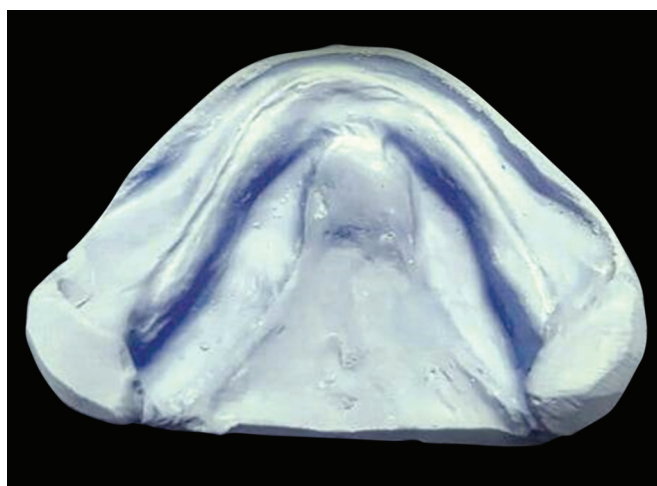


Fig. 6: Master cast of wire Impression technique was poured with die stone

Statistical Analysis

Data collected from retentive force readings was organized in tables and then analyzed within and between the four impression techniques. The level of significance was adjusted to $p \leq 0.05$. Statistics were done using SPSS version 21 (IBM Inc., Armonk, New York, USA).

RESULTS

Comparison of Retention in Each Group

Descriptive statistics mean value, and standard deviation (SD), for retention measured in N recorded for each group, is summarized in Table 1 and graphically represented in Figure 7.

The retention for group I ranged between minimum value (7.13 N) and maximum value (13.722 N) and mean \pm SD values were $(9.994 \pm 1.947$ N), the retention for group II ranged between minimum value (9.5 N) and maximum value (17.93 N) and mean \pm SD values were $(13.29 \pm 2.87$ N), The retention for group III ranged between minimum value (9.62 N) and maximum value (21.423 N) and mean \pm SD values were $(15.802 \pm 3.7$ N) and the retention for group IV ranged between minimum value (9.13 N) and maximum value (25.92 N) and mean \pm SD values were $(17.106 \pm 5.79$ N).

Table 1: Retention results mean \pm SD values for each type of impression technique

Variable	Mean	SD	Range	
			Min	Max
Group I (Conventional impression tech)	9.944	1.94	7.13	13.22
Group II (Cocktail impression tech)	13.292	2.87	9.51	17.93
Group III (Modified functional impression tech)	15.802	3.701	9.62	21.42
Group IV (Wire impression tech)	17.106	5.79	9.13	25.92
Statistics	<i>p</i> -value	0.001 ns		

ns, nonsignificant

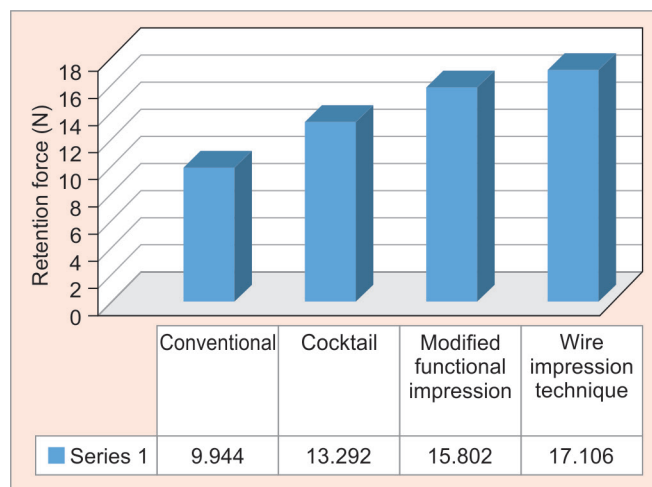


Fig. 7: A column chart comparing retention mean values between different types of final impression

Comparison of Retention between Groups

In comparisons between the studied groups, there were statistically significant differences between groups I and II, I and III, I and IV, II and III, and III and IV. The *p* value was less than 0.001 for both groups, whereas group III and group IV did not differ statistically significantly (*p*-value = 0.1) (Table 2).

Effect of Impression Techniques on Retention Force

According to the impression technique, group IV showed the highest mean retention value, followed by group III and then group II. In contrast, the lowest mean retention was found in group I.

DISCUSSION

Resorption ridges are commonly seen in older patients.²⁰ Dentists are challenged with fabricating stable dentures for these patients. An additional problem with the atrophic mandible is its inability to withstand chewing forces caused by the residual ridge. Furthermore, since the muscles are attached to the crest of the ridge, a greater degree of dislocation can be achieved.²¹

A good impression is crucial to keep the complete denture stable and the patient physiologically comfortable. Therefore, the study will evaluate the effect of different impression techniques for the resorbed mandibular ridge on the retention of a lower complete denture.²²

Table 2: Comparisons between the studied groups

Group I vs Group II	Mean = 9.944 Mean = 13.292	<i>p</i> -value = 0.01 ns
Group I vs Group III	Mean = 9.944 Mean = 15.802	<i>p</i> -value = 0.00 ns
Group I vs Group IV	Mean = 9.944 Mean = 17.106	<i>p</i> -value = 0.00 ns
Group II vs Group III	Mean = 13.292 Mean = 15.802	<i>p</i> -value = 0.00 ns
Group II vs Group IV	Mean = 13.292 Mean = 17.106	<i>p</i> -value = 0.00 ns
Group III vs Group IV	Mean = 15.802 Mean = 17.106	<i>p</i> -value = 0.1 ns

ns, nonsignificant

The study excluded patients with abnormal salivation, regardless of whether the patient had systemic disease or was taking systemic drugs. Since salivary wetting is definitely necessary to ensure adhesion, cohesion, and surface tension, which ultimately leads to improved prosthesis retention, the retention measurement procedures were also facilitated by excluding patients with severe undercuts on their ridges, which are believed to affect retention.²³ Although no matter how it's described, there can never be any doubt about the importance of the temporomandibular joint, neuromuscular coordination, tongue size, maxilla-mandibular relationship, and mucosal health for retaining dentures. Therefore, standardizing the criteria for those factors was necessary in order to eliminate their impact on denture retention.²⁴

This study focused on resorbed mandibular ridges rather than the maxilla due to the anatomical differences and the primary and secondary stress-bearing areas in the mandible.¹⁸

In brief, the results of the study showed that modified functional impression and wire impression techniques had significant differences from conventional and cocktail impression techniques.

It is in accordance with some of the research that functional impression techniques are superior to conventional impression techniques due to several advantages: it saves time, eliminates interference from tray handling, reduces the chances of under- and overextensions due to the patient performing the movements, and the pressure that the patient applies during impression making is the same as that used while occluding.^{16,25,26}

Additionally, Abdel-Hakim et al.,²⁷ found that the modified functional impression technique was more effective at retaining complete dentures. This is because viscoelastic properties were maintained, which is crucial to clinical success with functional impressions. Flowing material determines the exact shape of tissues' borders after a certain period of time. When under functional stress, a functional impression should be able to adapt to changing soft tissues, while exhibiting minimal elastic recovery.

As the wire impression technique showed the highest mean retention among all groups, this can be attributed to its ability to fit dentures closely to the tissues and to the fact that retention is proportionate to the amount of surface area covered. In addition, it has been called a selective impression technique, since the relief is made before the final wash.²⁸ According to studies observed in selective pressure impressions of edentulous mandibles, a tray with relief reduces image pressure on the crest of the alveolar ridge. It transmits forces to the stress-bearing area and reduces bone resorption.²⁹

Based on the results, which were compatible with Craddock, selecting pressure impressions gave dentists good evidence.³⁰ Moreover, Shah et al. proved that functional impressions and selective pressure techniques can provide successful denture fabrication for patients with resorbed ridges.³¹

It is important to note, however, that the present study design has some limitations, such as only evaluating retention for one type of denture base (heat-cured acrylic resin). Furthermore, neither patient satisfaction scores nor post-insertion adjustment appointments for each impression technique were examined in this study. Additionally, a larger sample size and a longer follow-up period might be useful when analyzing results in a clinical setting. It is also possible to explore some aspects of complete denture impressions in more depth, such as comparing mandibular retention with different denture base materials made with different impression techniques.

CONCLUSION

Wire impressions produce lower dentures with higher retention, whereas conventional impressions produce lower dentures with the lowest retention, so it is considered to be more advantageous.

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