



## Evaluation of the effect of two different impressions materials on the retention of complete dentures. An in vivo study

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### Abstract

**Background and objectives:** The choice of impression technique and material can influence the accuracy of the final prosthesis. This study aims to assess the impact of two impression methods and materials on denture retention.

**Methods:** This non-randomized clinical trial was carried out on 30 fully edentulous patients in the College of Dentistry and in Duhok Dental Polyclinics from October 1, 2022, to June 30, 2023. For each participant, two sets of maxillary impressions were taken. The first impression was done with zinc oxide eugenol impression paste and green stick compound for border molding by using a special tray, and the second impression was completed with polyvinyl siloxane impression material on a stock tray using the putty-wash technique. Two stone casts were made for each participant, and two denture bases with wire loops in the middle were fabricated. Using a digital force gauge, the intra-oral retention force was evaluated in both groups.

**Results:** The denture base fabricated with polyvinyl siloxane impression material had a mean retention value of 3.88 kg and 3.89 kg for males and females, respectively, while the mean retention value of zinc oxide eugenol paste for males and females was 3.63 kg and 3.72 kg, respectively, with a p value of 0.3518. The difference was non-significant.

**Conclusion:** Dentures made using polyvinyl siloxane final impression material showed higher mean retention values of complete denture retention than zinc oxide eugenol final impression material.

**Keywords:** Complete dentures, Green stick compound, Impression Polyvinyl siloxane, Zinc oxide eugenol

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## Introduction:

Denture retention is a major challenge for prosthodontists, and the effectiveness of denture therapy is determined by providing retention and stability with the ability to withstand occlusal forces. The retention of complete dentures is particularly important to ensure patient satisfaction and long-term success.<sup>1</sup> Typically, the anatomical characteristics of the edentulous ridges play a critical role in denture retention. The size and shape of the ridge can affect the surface area available for denture support, and the elasticity of the tissue can affect the ability of the denture to adhere to the ridge. In addition, the underlying bone density and contour can affect the stability and retention of the denture. In addition to the correct extension and fit of the denture base to the underlying tissue, denture retention is also important.<sup>2</sup> Complete denture retention depends on physical factors such as adhesion, cohesion, salivary film thickness, surface tension and atmospheric pressure. Accurate denture base dimensions improve fit and adaptation to oral tissues.<sup>3</sup> Clinical techniques such as border molding, accurate final impression and proper occlusion are essential to achieve optimal denture retention. These procedures help to ensure that the denture fits well and is comfortable, which is critical for maintaining effective retention and overall patient satisfaction with their denture.<sup>4</sup> The border molding process is an essential step in the fabrication of complete dentures, with the primary objective of creating peripheral seals. These seals involve achieving a tight contact between the margin of the denture base and the underlying mucosa, which serves to prevent the ingress of air between the base and the oral tissues.<sup>5, 6</sup> Greenstick molding compound is a commonly used material for border tracing. This substance exhibits thermoplastic characteristics and has a low heat conductivity of approximately 49°C to 60°C and a curing temperature of

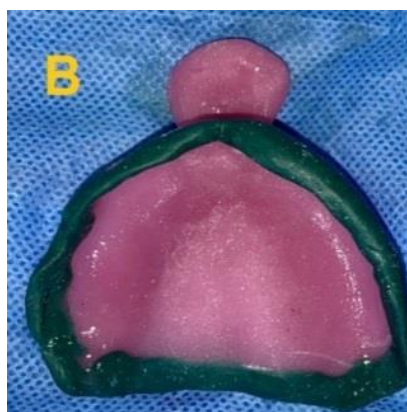
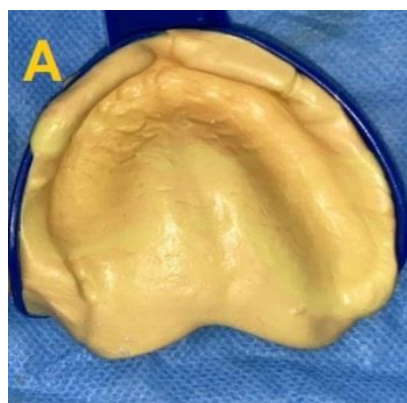
37°C. These properties allow the material to be easily molded and shaped to create precise contours of the denture base while reducing patient discomfort during the molding process.<sup>7, 8, 9</sup> Zinc oxide eugenol is a commonly used final impression material that is often preceded by tracing the borders with a low-fusing material. Zinc oxide eugenol is favored for its fast-setting time, ability to accurately reproduce fine detail and ease of handling with minimal dimensional change after setting. However, its use can be limited by factors such as potential heat irritation to oral tissues and the presence of undercut areas, which may require the use of additional materials such as polyvinyl silicone putty to achieve proper denture retention and patient comfort. The incorporation of polyvinyl siloxane impression material in undercut areas allows for proper accommodation in the peripheral sulcus, resulting in improved denture retention and patient comfort.<sup>10</sup> Silicone, particularly polyvinyl putty consistency, is commonly used for precise border molding in denture fabrication because of its ease of molding, uniform texture and slow setting time, which ensures accurate reproduction of oral tissue contours for better denture retention and stability.<sup>11</sup> Another advantage of polyvinyl siloxane over zinc oxide eugenol for the final impression in denture fabrication is that it eliminates the need for a special tray. Zinc oxide eugenol requires the use of a custom tray to obtain an accurate final impression of the oral tissues, which can be time-consuming and expensive. In contrast, polyvinyl siloxane can be used with a stock tray, reducing the number of impression steps and simplifying the overall process. The study aimed to evaluate and compare the retention of complete denture bases made with two different final impression materials and two different techniques.

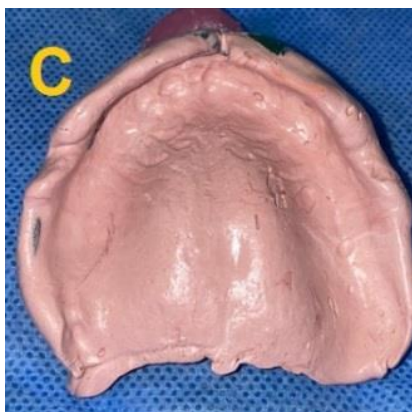


## Patient and methods:

The present non-randomized clinical trial was conducted in the clinics of the prosthodontics department in the College of Dentistry at Duhok University and in Duhok Dental Polyclinics from October 1, 2022 to June 30, 2023. Thirty patients seeking prosthetic rehabilitation who were completely edentulous and between the ages of 40 and 65 were chosen at random to serve as the subjects. The exclusion criteria for the selected patients were: fibrous ridge, ridge resorption, tissue undercuts, and bony exostoses and tori. All participants received information about the study and were asked for their written consent. Ethical approval was obtained from the Duhok General Directorate of Health and the Ministry of Health Ethics Committee before the study commenced. Two different impression techniques for the maxillary arch were made for each patient; the first impression was done with zinc oxide eugenol paste (SS White® impression paste; Prima Dental Group, Gloucester, UK. Exp:2027-3-18) using a special tray, and the second impression was completed with polyvinyl siloxane impression material (Smart Sil®; SeilGlobal Co. Busan, Korea; Exp:2024-3-3) using a plastic stock tray. All impressions were poured with type 3 dental stone (QuickStone Type 3: Whip Mix Co. Farmington Avenue, USA. Exp:2023-12-26) to produce 60 master casts, on which 60 temporary denture bases were fabricated with heat-cured acrylic denture base material (Major Base; polymethylmethacrylate type I-Class I, Major Prodotti Dentari SPA, Moncalieri, Italy; Exp: 2023). For the first impression technique, an appropriate stock tray was selected for each patient, and a primary impression of the maxillary arch was taken with a putty-consistency condensation silicone impression material (Protesil®putty; Vannini Dental Industry, Italy, Exp:2025-06), Figure (1A). The primary impression

was then poured with dental stone to form the primary cast, on which a custom tray was fabricated using auto polymerized acrylic resin (BMS Dental Resin Self-curing, Capannoli, Italy, Exp:2026-03). The custom tray was adjusted in the patient's mouth to ensure a distance of 2 mm between the tray margins and the depth of the sulcus, which would allow accurate molding of the oral tissues. The margins were then molded using green stick compound impression material (Harvard impression compound green, Harvard Dental International GMBH, Hoppegarden, Germany, Exp: 2023-7), Figure (1B). The final impression for the patient was then taken using zinc oxide-eugenol impression material, which was carefully mixed, and added to the custom tray, and placed in the patient's mouth. After setting, the impression material was removed and evaluated for accuracy and precision, Figure (1C).

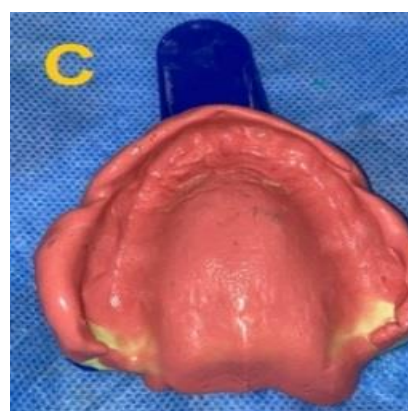
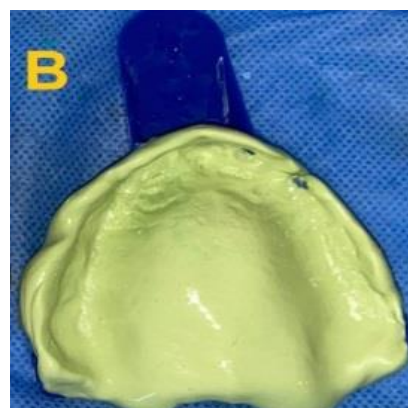




**Figure (1).** Primary impression with putty consistency condensation silicon (A), green stick compound border tracing (B), Zinc oxide eugenol final impression (C)

For the second impression technique, the final impression was taken in one visit using the polyvinyl siloxane two-step putty-wash impression technique. An appropriately sized perforated plastic stock tray was selected and modified according to the sulcus depth and frenal areas, either by trimming or adding wax to the edges of the tray so that the final length of the tray is 2 mm less than the depth of the sulcus, allowing sufficient space for the impression material. The accuracy of the tray was checked by fitting it to the patient's mouth, Figure (2A). In the first step, border molding and the primary impression were taken simultaneously using putty polyvinyl siloxane. An appropriate amount of putty was mixed and placed on the tray, which was then inserted into the patient's mouth. The putty was adapted to the contours of the oral tissues by stretching the lips and cheeks, including the frenal areas. After setting, the impression was removed and checked for accuracy. Any excess material was trimmed with a scalpel and adjusted as necessary, Figure (2B). In the second step, the final impression was taken using a light body cartridge impression material. The obtained primary impression was used as a special tray, and the light-body

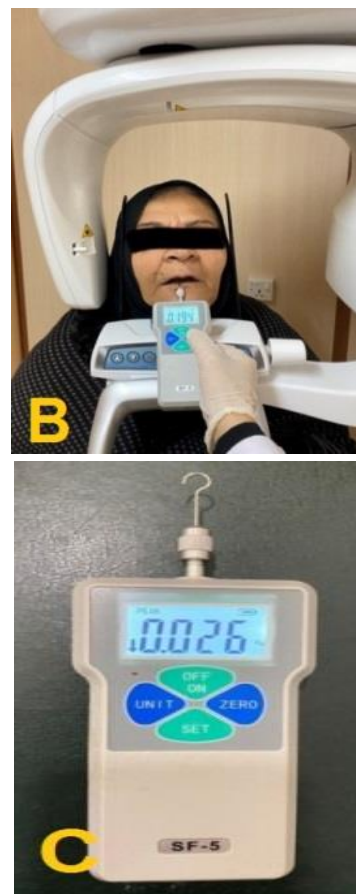
polyvinyl siloxane was loaded over the primary impression, including the margins, to obtain the final impression, Figure (2C). This two-step technique can help reduce the number of patient visits and overall treatment time while ensuring accurate and precise impressions.



**Figure (2).** Modified plastic stock tray (A), 1st impression with putty consistency (B), 2<sup>nd</sup> impression with light body (C)



For each participant, two stone casts were made from each impression technique, and two heat-cured acrylic denture bases were fabricated on the casts. A stainless-steel wire loop (0.9" gauge) was attached to the denture base in its anterior palatal area, nearly corresponding to a line connecting the distal surfaces of the canine eminences, Figure (3A). For measuring the retention force of the denture bases, the participant stood in an upright position with the head position stabilized and standardized using a head stand and chin rest of a panoramic radiograph machine, in a way that the maxilla was parallel to the floor. This ensured that the forces applied to the denture bases were consistent across participants and minimized any potential sources of bias, Figure (3B). The denture base was rinsed, inserted into the patient's mouth, and stabilized with the operator's fingers for 30 seconds before the retention force was measured using a specially designed digital force gauge (CDC Yankee, model: SF-5), Figure (3C). The force gauge was connected to the U-shaped loop in the denture base using a hook, allowing accurate measurement of retention force. To eliminate any potential sources of bias, each denture base was pulled downward until it was displaced from the mouth. Five measurements were taken for each denture base, and the mean was recorded. The data were statistically analyzed to compare the retention values of the two impression techniques.



**Figure (3).** Base plate with stainless steel wire (A), patient standing during retention test (B), digital force gauge (C)

## Results

The impressing values of both zinc oxide eugenol and polyvinyl siloxane impression materials were determined by mean and standard deviation. The comparisons of retention of complete dentures between zinc oxide eugenol and polyvinyl siloxane impression materials and between the genders were examined using an independent t-test. The correlations between the impression made by ZOE and polyvinyl siloxane materials were examined by bivariate regression. A p value of less than 0.05 was considered to indicate a significant difference in impression. Statistical calculations were performed using JMP Pro (14.3.0).



**Table (1):** mean retention value for the polyvinyl siloxane impression and the mean retention value for the zinc oxide eugenol impression.

| Impression materials                                          | Number | Mean | Std Dev | p-value |
|---------------------------------------------------------------|--------|------|---------|---------|
| Polyvinylsiloxane impression                                  | 30     | 3.89 | 0.86    | 0.3518  |
| ZOE impression                                                | 30     | 3.67 | 0.97    |         |
| ZOE Impression                                                |        |      |         |         |
| Gender                                                        |        |      |         | 0.8055  |
| Male                                                          | 19     | 3.63 | 1.01    |         |
| Female                                                        | 11     | 3.72 | 0.93    |         |
| Polyvinylsiloxane impression                                  |        |      |         |         |
| Gender                                                        |        |      |         | 0.9785  |
| Male                                                          | 19     | 3.88 | 0.87    |         |
| Female                                                        | 11     | 3.89 | 0.89    |         |
| An independent t-test was performed for statistical analyses. |        |      |         |         |

Table (1) shows that the mean retention value  $\pm$  (SD) was  $3.89 \pm 0.86$  kg for the polyvinyl siloxane impression and the mean retention value  $\pm$  (SD) was  $3.67 \pm 0.97$  kg for the zinc oxide eugenol impression. Statistical analysis using a non-paired t-test showed no significant difference between the two groups. With regard to gender, there were 19 males and 11 female patients, and statistical analysis shows an insignificant difference between male and female patients for both zinc oxide eugenol and polyvinyl siloxane impression techniques. The mean retentive value and standard deviation in males and females were very close at  $3.63 \pm 1.01$  kg and  $3.72 \pm 0.93$  kg, respectively, for the ZOE impression. For the polyvinyl siloxane impression, the mean retentive value and standard deviation were almost the same for males and females,  $3.88 \pm 0.87$  kg and  $3.89 \pm 0.89$  kg, respectively.

## Discussion

Zinc oxide eugenol is a commonly used impression material in prosthodontics because of its accuracy and ability to distribute pressure evenly. Zinc oxide eugenol is a monostatic material that can take detailed soft tissue impressions without

causing tissue displacement, but it has a limitation in that it cannot be used in undercut areas.<sup>12</sup> In prosthodontics, polyvinyl siloxane impression materials are often preferred due to their ability to produce highly accurate impressions, dimensional stability, ease of use, and high elastic recovery.<sup>13-15</sup> Based on the results of this study, it may be necessary to re-evaluate the routine use of zinc oxide eugenol as a final impression material after the green stick compound for complete denture impressions. The results suggest that the introduction of a new technique using the putty consistency of polyvinyl siloxane for both border tracing and primary impressions, followed by a light-body material for final impressions, would be of significant benefit in reducing patient discomfort and clinic time. This study compared the retention of maxillary denture bases formed by two various impression materials and methods. Patients with well-formed residual ridges but without significant undercuts were chosen in order to avoid mechanical influences on denture retention. The results of the study showed that the denture bases made with a putty consistency polyvinyl primary impression combined with a light-body silicone final impression material had higher retention values than those made with a special tray molding technique using green stick compound and zinc oxide eugenol for the final impression. These results can be attributed to the characteristics of the polyvinyl siloxane impression material used, which offers excellent manipulation consistency, elasticity, and dimensional stability. The material can be accurately molded by the tissues during muscle movements, resulting in a uniform perimeter around the peripheral seal, which may have contributed to the uniform margin thickness and smooth continuity, observed in the denture bases, resulting in denture bases with higher retention values. There are a number of explanations for why denture bases made



using polyvinyl siloxane primary impression and light-body silicone final impression material have higher retention forces than bases made using full green stick tracing and zinc oxide eugenol final impression. One possible explanation is related to the properties of the green stick tracing material, which is softened by a dry heat flame during the impression process; this method may alter the flow and texture properties of the material, which may become too hard and unholdable. Another cause may be premature tissue contact with the tracing material before it is in the correct position. The findings of this study agreed with earlier studies Appelbaum<sup>16</sup>, which suggest using elastomers as the preferred material for border tracing and final wash impressions. A study conducted by Tasleem et al.<sup>17</sup> and Kikuchi et al.<sup>18</sup> analyzed patient satisfaction by assessing the stability, retention, time, and comfort during marginal molding through the use of two materials: polyvinyl siloxane and green stick wax. The results showed no significant difference between the two techniques regarding retention, stability, and comfort. These results are similar to those obtained in our study. The current study showed that the mean retention value was  $3.88 \pm 0.86$  for polyvinyl silicone impressions and  $3.67 \pm 0.97$  for zinc oxide impressions, which agreed with the findings of Olivieri et al.<sup>19</sup> and Al-Judy.<sup>6</sup> which were done on 14 fully edentulous patients, comparing the effect of different molding and final impression materials on the retention of maxillary complete denture bases. The study found that denture bases made with full and posterior putty silicone rim molding combined with light-body silicone resulted in higher retention compared to other tracing techniques. In addition, Rizk.<sup>10</sup> evaluated the complete denture retention using different margin molding materials, including green stick compound, medium rubber base, and putty rubber base, and found that the putty

rubber base had the highest value of mean retention, followed by the medium body, while the lowest value was with the green stick compound; these results are consistent with the present study. Regarding the retention values of dentures according to gender, a non-significant difference was found between male and female patients because the retention value depends mostly on local factors such as the type of residual ridge, the amount of ridge resorption, the quality and quantity of saliva, and other factors such as the materials and techniques used for impression taking and denture base construction.

### Conclusion:

Using polyvinyl silicone impression material with a stock tray can indeed provide excellent impression quality for complete dentures. This method is often preferred over older techniques like green stick compound and zinc oxide eugenol paste, as it can offer more precision and accuracy.

### Disclosure:

The authors assert that they have no conflicts of interest.

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