Association between Handling of Alginate Impression and Quality of Dentures

Bolanle Oyeyemi Akinboboye, Olugbenga A. Adenuga-Taiwo[1], Paul I. Idon[2], Linda Oge Okoye[3], Patricia Adetokunbo Akeredolu

Department of Restorative Dentistry, Faculty of Dental Sciences, University of Lagos, [1]Department of Restorative Dentistry, Lagos State University, Lagos, [2]Department of Dental Surgery, University of Maiduguri Teaching Hospital, Maiduguri, [3]Department of Restorative Dentistry, University of Nigeria, Nsukka, Enugu State, Nigeria

Abstract

Objectives: Alginate impression commonly used in denture fabrication has drawbacks, which affects the quality of dentures. The objective is to determine the association between handling of alginate and denture quality. **Materials and Methods:** A structured questionnaire was administered to dental personnel, managing patients that required removable prosthesis in a multicenter cross-sectional pilot study. Information gathered were that of age, sex, number of teeth replaced, manipulation of impression material, disinfection of impression material, and quality of dentures. Likert scales were used to rate the participants' manipulation of alginate impressions and the quality of dentures. **Statistical Analysis:** Data were collated and analyzed with the Statistical Package for the Social Sciences version 20. Differences between categorical variables were tested for significance using Chi-square tests, and Student's *t*-test was used for means. A linear relationship between variables was tested using correlation statistics, and all statistical significance was inferred at $P < 0.05$. **Results:** Sixty-nine participants with a mean age of 27.00 ± 6.93 (20–57 years) took part in this study. The proportion of females seen was 55.1%. The mean number of dentures fitted was 10.03 ± 5.44, and 5.14 ± 2.71 dentures were relined annually. The most common partial edentulous case was Kennedy Class III (72.5%). There was a weak but insignificant positive association ($r = 0.19$, $P = 0.12$) between the quality of denture and handling of alginate impression material. There was also no significant correlation between the years of experience of the participants and scores for quality of denture ($r = 0.02$, $P = 0.86$) nor handling of impression by the participants ($r = -0.07$, $P = 0.57$). **Conclusion:** The participants' handling of alginate impression did not influence the quality of partial dentures made from them.

Keywords: Alginate impression, denture quality, handling, quality, removable partial dentures

Introduction

Acrylic dentures are the most common tooth replacement option[1,2] in our environment,[1] and its quality affects oral health.[3-5] There is a need for improvement in quality[6] as poor quality can result in loose denture[2] and subsequently a reline[7,8] which is also used to assess the quality of dentures.[9] Improvement in quality can be done by proper handling of materials and fabrication process.[6]

Findings have shown agreement between patients' appreciation of fit and clinical assessment of denture quality.[10] Conventional or digital methods can be used to evaluate overall fit and accuracy.[11] There is no significant difference between using conventional or digital methods.[12] Alginate impression has been documented to have drawbacks affecting denture fit if not properly handled.[13,14] The aim was to determine the effect of alginate handling on acrylic denture quality.

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Materials and Methods

This study was a multicenter cross-sectional study of dental personnel. The participants were recruited from prosthetic clinics in Lagos University Teaching Hospital, Lagos State University Teaching Hospital, University of Maiduguri Teaching Hospital, and University of Nigeria Teaching Hospital, all of which are teaching hospitals located in different regions in Nigeria. All participants were fitted with acrylic dentures (this does not require denture design since it is not metallic based denture).

Address for correspondence: Dr. Bolanle Oyeyemi Akinboboye, Department of Restorative Dentistry, Faculty of Dental Sciences, University of Lagos, Lagos, Nigeria.
E-mail: bakinboboye@unilag.edu.ng

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Alginate impression was also used in the construction of all dentures in this study. A structured questionnaire developed according to principles in the literature was used.[14,15] This questionnaire was pretested and administered to dental personnel including consultants, senior registrars, registrars, house officers, and clinical dental students currently working in the posting (prosthetics) or on rotation in the department. The participants were trained on filling the questionnaire.

The study period was 3 months, and data from all removable prostheses fitted during the study period in the clinics by the participants were recorded into a questionnaire. All prostheses were fabricated according to standard laboratory practice. The following information was recorded: age, sex, teeth replaced, type of denture (upper arch/lower arch), impression material used, manipulation of impression material, disinfection of impression material, retention, stability, and general fit of denture. Likert scale was used to rate the manipulation of impression materials. Mouth preparation had the highest score of 5, removal of impression material (highest score of 5), time taken to pour cast (highest score of 5), placement of alginate impression material before it is poured (highest score 3), and disinfection of impression material (highest score 5). The total maximum score for handling alginate impression material was 23. The quality of denture was determined by the sum of denture fit score, retention score, and stability score. These were rated individually using Likert scale in accordance to previous study: 1 was rated poor quality, 2 was rated fair, 3 rated good, 4 rated very good, and 5 rated excellent.[16,17] The total maximum score for quality of denture was 15.

Statistical analysis

The data were collated and analyzed with the Statistical Package for the Social Sciences (SPSS) for Windows (version 20, SPSS Inc., Chicago, IL, USA). Data were presented in tables and expressed in counts, percentages, and means. Differences between categorical variables were tested for significance using Chi-square tests, and Student's *t*-test was used for means. A linear relationship between variables was tested using correlation statistics, and all statistical significance was inferred at $P < 0.05$.

Results

Sixty-nine participants with a mean age ± standard deviation (range) of 27.00 ± 6.93 (20–57) years and mean number of years of experience of 5.80 ± 3.39 took part in this study. The proportion of females seen was 55.1%. Majority of the dentures (92.7%) were fitted by dental personnel below the cadre of a senior registrar, with most (82.6%) of these handled by the house officers and clinical dental students [Table 1]. All impressions were made with alginate material. Kennedy Class III partial edentulous case was the most common (72.5%) seen. The mean number of dentures fitted and relined annually was 10.03 ± 5.44 and 5.14 ± 2.71, respectively.

Table 2 shows the mean scores for the different protocols for impression handling and their proportion of the maximum score obtainable for each protocol. The highest mean score was noted in the technique for "removal of impression from the mouth" (4.20 ± 1.12) and the lowest in "placement of impression prior to pouring of cast" (2.03 ± 0.87). Retention was rated the lowest (68.4%) of the parameters for quality of dentures. The overall score for impression handling was 17.11 ± 3.46, while the score for quality of denture was 12.03 ± 3.79, both of which are above 70% of the proportion of the maximum score obtainable.

Table 1: Participants' sociodemographics and characteristics

Variables	Frequency (%)
Age group	
20-25	43 (62.3)
26-30	15 (21.7)
31-35	6 (8.7)
36-40	0
41-45	2 (2.9)
46-50	0
51-55	2 (2.9)
56-60	1 (1.5)
Designation	
Consultant	3 (4.3)
Senior registrar	2 (2.9)
Junior registrar	7 (10.2)
House officer	27 (39.1)
Student	30 (43.5)
Specialty	
Prosthodontics	6 (8.7)
Orthodontics	1 (1.4)
Pedodontics	1 (1.4)
Conservative	1 (1.4)
Oral and maxillofacial surgery	3 (4.4)
None	57 (82.7)
Dentures fitted annually	
1-5	24 (34.8)
6-10	29 (42.1)
11-15	5 (7.2)
16-20	11 (15.9)
Dentures relined annually	
1-5	63 (91.4)
6-10	5 (7.2)
20	1 (1.4)
Total	69 (100)

The difference in the mean number of fitted dentures by participants with ≥10 years' experience (9.38 ± 5.11) and personnel with experience of 0–9 years (15.71 ± 5.35) was significant ($P = 0.03$) [Table 2].

The mean number of dentures relined by dental personnel with 0–9 years' experience was lower than those with ≥10 years' experience, and this was statistically significant ($P = 0.04$). The proportion of fitted dentures that were relined was higher for participants with lesser experience (52.45%), compared to those with experience of 10 years or more (45.45%) [Table 3].

Table 2: Mean scores for impression handling techniques and overall mean score

Factors	Mean±SD	Percentage of maximum score
Handling of impression		
Mouth preparation prior to impression taking	3.42±1.63	68.40
Removal of impression from mouth	4.20±1.12	84.00
Time spent before pouring impression	4.00±1.21	80.00
Placement of impression prior to pouring cast	2.03±0.87	67.67
Disinfection of impression material	3.45±1.09	69.00
Total mean score	17.11±3.46	74.39
Quality of dentures		
Fit of denture	4.33±1.42	86.60
Denture retention	3.42±1.14	68.40
Denture stability	4.28±1.35	85.60
Total mean score	12.03±3.79	80.20

SD: Standard deviation

Table 3: Comparison of mean number of fitted and relined dentures by years of experience

Variables	Years of experience (years)	Mean±SD	Standard error of mean	*T*	*P*
Dentures fitted	0-9	15.71±5.35	2.02	−3.09	0.03
	10-20	9.38±5.11	0.65		
Dentures relined	0-9	4.92±2.64	1.22	−2.11	0.04
	10-20	7.14±2.67	0.34		

SD: Standard deviation

There was no significant correlation between the years of experience of the participants and scores for quality of denture ($r = 0.02$, $P = 0.86$) and scores for handling of impression by the participants ($r = -0.07$, $P = 0.57$) [Table 4]. There was also a weak positive but statistically insignificant correlation between the scores for denture quality and handling of impressions by the participants ($r = 0.19$, $P = 0.12$) [Table 4].

Table 4: Correlation between years of experience, handling of impression, and denture quality scores

Variables	Years of experience	Quality of dentures	Handling of impression
Years of experience			
R	1	0.02	−0.07
P		0.86	0.57
Quality of denture			
R	0.02	1	0.19
P	0.86		0.12
Handling of impression			
R	−0.07	0.19	1
P	0.57	0.12	

Discussion

In this study, the most common partial dentate case managed was that of Kennedy Class III, a finding that is consistent with previous reports[18,19] that bounded saddle is the most prevalent. Other studies have noted the prevalence of Kennedy Class I and Class II[20,21] although reasons for findings were not documented. Previous report shows that the most frequently missing teeth were the mandibular first molar teeth.[22] That could explain why Kennedy Class III was prevalent in this study. Impression making for dentures is believed to be central to the success of the prosthesis made from them.[23] Alginate impression material is used in all the prosthetic clinics included in the study and was the impression material used for all removable partial denture impressions in this study. With the continued controversy on the most suitable impression material for use in the fabrication of removable prosthesis, whichever the preferred choice, the favorable impression-specific handling techniques affect the quality of the denture.[23] Alginate is the most common impression material in use because of its cost-effectiveness, but its major drawback is in its dimensional instability that produces ill-fitting dentures.[14] These ill-fitting dentures will require relining to improve their quality.[23] It has been documented that various factors can cause dimensional changes of impression material; these include friction between impression material and teeth, proportion of filler, bulk of impression material, size of trays, type of impression trays, time of impression removal, manner in which impression was removed from the mouth, type of stone used to pour impression material, storage time, and chemical disinfecting methods.[24-27]

There are various factors that can affect the accuracy or stability of alginate impression material and invariably result in ill-fitting dentures. Increased storage time of alginate results in discrepancy and large loading of filler results in decreased discrepancy.[28]

Patients' perception of denture fit and function, clinical assessment of quality,[16] and the proportion of fabricated

dentures that required/require relining[23] can be used as measures of denture quality. We assessed denture quality in our study using the two latter methods. The factors in handling of alginate impression material that was considered in the clinic for this study were mouth preparation to reduce friction between teeth and impression material, method of removal in the mouth, disinfection method, and storage time before pouring. Other factors that would affect the accuracy of impression would be bulk of impression material used and time of removal of impression,[24-27] and these were not considered in this study. All impressions were made with perforated stock trays, and the type of stone was beta-hemihydrate gypsum (which can give accurate and stable results).[29] The number of dentures relined annually in this study was about 50% of the dentures fitted within the same period.

The proportion of the fitted dentures that were relined was noted to be higher among those with <10 years' experience and may indicate that years of experience have an impact on denture quality. Although causes for the relines were not gathered, this finding is rather disturbing, as poor alginate impression handling could be a reason for ill-fitting dentures necessitating the relines. It should be noted that majority of participants were either clinical dental students or house officers with little experience, though assumed to have worked under supervision by consultants.

The parameters of mouth preparation prior to impression, technique of impression removal from the mouth, disinfection of impression, placement of impression prior to pouring, and interval before impression is poured were used to assess the handling of the alginate impressions of ongoing removable partial denture work. Several authors have reviewed handling of alginate impression and have laid out proper procedures for its handling to achieve optimum impressions for denture fabrication.[30] Nonadherence to one or more of the proper techniques for these procedures could result in poorly made dentures with poor stability, retention, or fit. In the preparation of the mouth prior to impression making, the occlusal surfaces of the teeth are to be dried with an air syringe to minimize air blows, remove debris and saliva to allow the alginate radicals in the impression material form chemical bonds with hydroxyapatite crystals of the enamel, and allow alginate to be removed without tearing, giving accurate surface details. This ensures that accurate surface details are replicated on the impression.[31,32]

When taking impression, it is essential that the limiting structures such as the sulci must be considered by prepacking it, especially the lower lingual, upper labial, hamular notch, and distobuccal areas.[33,34] To allow accurate reproduction of the occlusal anatomy, the mixed alginate should flow onto the occlusal surfaces of the teeth,[34] palatal vault, and the tray must be adequately placed in the mouth in relation to the surrounding soft tissues. The tray should be lightly placed to prevent unseating of impression. On removal of impressions from the mouth, strains would be released. These strains can cause distortion and inaccurate cast; therefore, it should be removed by breaking the border seal.[35] Preferably, removal should be done with a quick snap, preventing twisting and rocking of the impression to reduce the contact time of distorted set impression against the teeth.[21] Removal of impression from the mouth had the highest mean score in scoring for handling of alginate impression material among the participants in this study.

Impressions should be poured immediately to make a cast to prevent syneresis and imbibition[36] but should first be placed under running water to remove saliva,[37] disinfected for 10 min in a chemical disinfectant, and time casted within 10–12 min[38] using gypsum material. In this study, the disinfectant used was 1% hypochlorite and the average score for time spent before pouring was 4.00 ± 1.21. Following disinfection, there is an appropriate way for placement of the set impression before the cast is poured. The lowest mean score for impression handling in this study was recorded for placement of impression prior to pouring of cast. The appropriate way would be to place the set impression on an instrument tray while it rests on the handle. This way, the overhanging set material protruding beyond the heel of the impression tray lies over the edge of the instrument tray and is not used for support. Placements with the heel of the impression tray on a hard surface would lead to distortion of the distal part of the impression.

In all, none of the scores of the five impression handling parameters studied were below two-thirds of the maximum attainable score. This relatively high performance in handling of impressions does not, however, explain the 50% annual reline rate of dentures fabricated by the participants. This may suggest that other contributors to the quality of dentures, not included in this study, other than the parameters of impression handling that we studied may be responsible. Furthermore, it may partly be explained by the fact that most (95.5%) of the dentures were handled by clinical dental students and those below the cadre of senior registrar. In addition, only 9.1% were handled by participants that were primarily specialists or specialist residents in prosthetics. This may explain why the scores obtained, on its own, for handling of alginate impression, had a direct positive relationship with quality of dentures fabricated from them but not significant. This study could, therefore, not prove among the participants studied that their handling of alginate impression had appreciable effects on denture quality. However, a negative relationship was found between years of experience and dentures fitted and relined annually. As already stated, there is a lack of available studies on the relationship of alginate impression handling and quality of dentures, thus limiting our ability to compare results. This study, being cross sectional, has limitations in relation to this type of study design and also on its reliance on the participants' self-assessments of impression handling and denture quality.

Conclusion

We conclude that better handling of alginate impression did not result in an appreciable increase in quality of acrylic dentures

regarding the fit, retention, and stability fabricated from them. A higher number of years of experience of operators in this study did translate to lower annual denture relines. Other factors such as laboratory procedures in the processing of partial dentures may be responsible for the high proportion of relines. These conclusions should, however, be interpreted in the context of practice where most removable partial dentures are handled by nonspecialists.

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Conflicts of interest

There are no conflicts of interest.

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