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Effect of Denture Base Reinforcement Using Light Cured E-Glass Fibers on the Level of Salivary Immunoglobulin A

Shady M. El Naggar[1*], Mohamed I. Seif El Nasr[2], Hassan M. Sakr[2], Sherihan M. Eissa[3], Asmaa N. Elboraey[3], Amani R. Moussa[3]

[1]Removable Prosthodontics, Faculty of Oral and Dental Medicine, South Valley University, Qena Governate, Egypt; [2]Removable Prosthodontics, Faculty of Dental Medicine Al-Azhar-Boys University, Cairo, Egypt; [3]Fixed & Removable Prosthodontics Department, National Research Centre (NRC), Giza, Egypt

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Keywords: denture base reinforcement; light cured E-glass fibres; salivary immunoglobulin A (S-IgA); complete dentures

***Correspondence:** Shady M El Naggar. Removable Prosthodontics, Faculty of Oral and Dental Medicine, South Valley University, Qena Governate, Egypt. E-mail: dr_shady_1985@dent.svu.edu.eg

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Abstract

BACKGROUND: A gap still exists between in vitro and clinical studies concerning the biocompatibility of the material in the oral environment and their potential to cause immunological undesirable side effects. The uses of glass fibres to improve the mechanical properties of acrylic resin denture base polymers are well documented in vitro.

AIM: The present study aimed to evaluate the effect of denture base reinforcement using light-cured E- glass fibres mesh on the level of salivary immunoglobulin A (S-IgA) in patients wearing complete dentures.

MATERIAL AND METHODS: Fourteen completely edentulous patients, in need of complete dentures, participated in the study. The patients were divided into two groups (n = 7) according to the treatment protocol. In the first group, patients received conventional heat-cured acrylic resin dentures. In the second group, the mandibular dentures were reinforced using light cured resin impregnated E glass fibres mesh. In both groups, salivary samples were collected using passive drool technique. The level IgA was assessed by enzyme-linked immunosorbent assay (ELISA) technique at different time intervals. Statistical analysis was carried out using one-way ANOVA followed by Tukey`s post-hoc test and independent t-test. The significant level was set at $P \leq 0.05$.

RESULTS: Acrylic resin dentures and reinforced ones demonstrated an increase in the mean values of IgA level at the end of the follow-up intervals. And this increase was statistically significant ($P \leq 0.05$). Although, the reinforced dentures revealed higher mean values, there was no statistically significant difference between the two groups ($P > 0.05$)

CONCLUSIONS: Within the limitations of the present study, the following could be concluded: (1) the insertion of complete dentures induced changes in the level of IgA; and (2) denture base reinforcement using light cured resin impregnated E-glass fibres mesh had a similar effect to that of heat cured acrylic resin on the level of IgA.

Introduction

For decades, acrylic resin complete dentures have been used to improve the quality of life for completely edentulous patients. The considerable cost, aesthetics, and ease of processing and repair of acrylic resin materials are the major reasons for its clinical success. However, fracture of dentures has been a challenging problem that occurred in 68% of the cases after 3 years [1] [2]. Maxillary denture fractures are mostly caused by fatigue and impact failure, while 80 % of mandibular dentures are fractured by impact [3].

Several attempts have been made to improve the mechanical properties of acrylic resin denture materials among them is the incorporation of reinforcing E-glass fibres. Although several studies documented the significant improvement in the flexural strength, impact strength and fatigue resistance of the acrylic resin material were attained. The processing of the fibres seems to be difficult and technique-sensitive [4] [5] [6] besides their poor bonding to the acrylic resin which is another shortcoming [3].

Advanced E-glass fibres mesh that is specially treated and impregnated with light cured resin have been recently introduced. A part from its strengthening and esthetic advantages it provides better bonding to the acrylic resin and, simpler manipulation through the use of a light curing system.

The reinforcement process involves the incorporation of new material into the dental prostheses [7]. Biocompatibility and mechanical characteristics are the principal parameters for the applications of new materials in the dentistry. The interaction between the oral environment and new materials may result in the release of biodegradation products which may cause local or systemic undesirable side effects [8].

Saliva is a complex mixture of secretions from major and minor Salivary glands where all the fixed and removable prostheses are immersed in[9]. Salivary immunoglobulin A (S-IgA) is the main immunoglobulin secreted by the immune system in the oral cavity. It compromises the first line of specific immune defence against pathogens, toxins and antigens at mucosal surfaces. The largest amount of sIgA is secreted by the minor salivary glands [10].

The effect of glass fibre reinforcement on the mechanical properties of acrylic resins has been investigated extensively [5] [6] [7]. However, a gap still exists between in vitro and clinical investigations concerning the materials biocompatibility and their potential to cause immunogenic adverse effects [11].

Therefore, the purpose of the present study was to evaluate the effect of denture base reinforcement using light-cured E-glass fibres meshwork on the level of salivary immunoglobulin A (S-IgA) in patients wearing complete dentures.

Material and Methods

Fourteen completely edentulous patients, in need of complete dentures, for the first time, were selected from the patients out clinic, Oral and dental medicine, Al Azhar University-Boys. The patient's age ranged from 45 to 60 years. The study protocol was approved by the Medical Research Ethics Committee (MREC: 18/081) of the National Research Centre. An informed written consent according was obtained from each participant before clinical procedures. All the participants were fulfilling the following inclusion criteria:

1. No previous denture experiences.
2. All of them were free of any systemic or local diseases that induce immune-competence reactions.
3. All were non-smokers.
4. They did not use any drugs that affect the oral mucosa.
5. They all were Angle Class I maxilla-mandibular relation.

Complete dentures construction

Patients were divided into two groups. In the first group (I) the acrylic resin (Across one, Dental & Medical Co, Egypt) complete maxillary and mandibular dentures without base reinforcement were delivered to the patients. The dentures were constructed following conventional procedures. In the second group (II), only the mandibular dentures were reinforced using a light cured resin impregnated with E-glass fibres meshwork (fibre force®, SYNCA, Canada). For the mandibular dentures, the reinforcement mesh was adjusted to the master cast with a 0.6 mm wax spacer.

On the waxed cast, four tissue stops were created using light-cured acrylic resin (SYNCA, Canada) supplied by the manufacturer. Then, the mesh was adapted to the cast using a vacuum unit (EZ VAC, SYNCA, Canada) and cured using the LED light curing unit (Dental Lab LED Light Cure Box, Taiwan) at 430 to 500 nm for 2 minutes. The cured meshwork was removed from the cast, flushed with boiling water stream to remove any wax remnants and dried.

The lower dentures were processed using the conventional method as the first group except that before flask closure the meshwork was placed on the master cast then packing and curing was performed. Thus, the meshwork bonded chemically to the denture acrylic resin

Immunologic evaluation

Salivary Sample collection: The samples were collected at four different time intervals: immediately before denture insertion (as control), two hours, three days and 7 days after complete denture delivery. Before collection of salivary samples, all patients were instructed not to ingest food or drinks (except water) at least for 60 minutes. The samples were collected between 10-11 AM to prevent any differences in the concentration of the saliva due to the circadian rhythm [12].

Ten millilitres of patient's saliva was collected in sterile plastic containers using passive drool technique [12] [13]. Then they were centrifuged at 3000 rpm for 15 minutes and the samples supernatant stored in a deep freezer at -20 degree and they were kept for analysis. The level of salivary IgA in the samples was assessed by using enzyme-linked immunosorbent assay (ELISA) (kit: Peritest, Robonik

India) and expressed as mg/dL.

Statistical analysis was performed using with SPSS 20® (Statistical Package for Social Science) and Microsoft Excel 2010. Data were represented as means (M) and standard deviation (SD).

Comparison of data within each group was made using one-way ANOVA followed by Tukey`s post-hoc test to evaluate the effect of time on the level of salivary IgA. Also, independent t-test was performed to detect the significance between both groups for each follow-up visit. The significant level was set at $P \leq 0.05$.

Results

Table 1 and 2 showed the IgA level during the follow-up periods of group I and II**.** Comparison of the effect of denture base reinforcement using mesh and conventional dentures on the level of salivary IgA was presented in Table 3.

In group I, when comparing the mean values of IgA before denture insertion and 2 hrs. Following denture use, there was an increase in the mean value; however, this increase was statistically insignificant ($P > 0.05$). On the other hand, after 3 and 7 days of denture use, there were an increase in the mean values of IgA and this increase was statistically significant ($P > 0.05$).

Table 1: the level of salivary IgA in group I

Time	M ± SD (g/L)	P-value
Before Denture Insertion (control)	90^{a} ± 6.24	0.00**
After Denture Insertion by 2 Hours	92^{a} ± 3.02	
After 3 Days	113^{b} ±7.47	
After 7 Days	132^{c} ±8.9	

M: Mean, SD: Standard Deviation, P: Probability level; Means with the same superscript letter were insignificant different; Means with the different superscript letter were significantly different; **significant difference.

Similarly, group II demonstrated an increase in the mean values of IgA following denture insertion. And this increase was statistically significant after 3 and 7 days of denture use ($P < 0.05$).

Table 2: the level of salivary IgA in group II

Time	M ± SD (g/L)	P-value
Before Denture Insertion (control)	94^{a} ± 5.4	0.00**
After Denture Insertion by 2 Hours	96^{a} ± 4.2	
After 3 Days	122^{b} ±8.7	
After 7 Days	142^{c} ±9.1	

M: Mean, SD: Standard Deviation, P: Probability level; Means with the same superscript letter were insignificant different; Means with the different superscript letter were significantly different; **significant difference.

Comparison of conventional dentures and reinforced ones (Table 3) revealed that reinforced light cured dentures showed higher mean values of IgA level during the follow-up periods. However, the increase in IgA means values were statistically insignificant ($P < 0.05$).

Table 3: Comparison of salivary IgA levels between the two groups

	M ± SD			
	Before Denture Insertion	After Denture Insertion by 2 Hours	After 3 Days	After 7 Days
Group I (Acrylic resin dentures)	90 ± 6.24	92 ± 3.02	113 ±7.47	132 ±8.9
Group II (Reinforced dentures with resin-impregnated E-glass fibres)	94 ± 5.4	96 ± 4.2	122 ±8.7	142 ±9.1
P-value	0.2239*	0.0633*	0.06*	0.0598*

M: Mean, SD: Standard Deviation, P: Probability level.

Discussion

S-IgA has an important role in the defensive mechanism where it participates in the immune reaction and protection of the mucous membrane of the oral cavity [10]. Furthermore, S-IgA concentration is related to the physiological status of the body [14] and oral cavity. The decrease in the level of S-IgA was reported to be associated with the increased risk for oral pathology [15]. On the other hand, the increase of S-IgA level had been correlated with low caries rate [16].

This study was planned to explore whether or not dentures reinforced with light cured resin impregnated E-glass fibres would affect the level of S-IgA in vivo compared to conventional acrylic resin dentures.

Only, healthy completely edentulous male patients with age ranging from 45 to 60 years participated in the study to exclude the possible effect of sex, age and general health status on the level of S-IgA [13] [14] [15] [16] [17] [18].

To assess levels of S-IgA in saliva, unstimulated salivary samples were collected using passive drool method in the present study as it is simple, inexpensive, acceptable for the analysis and more tolerable to the patients [19]. Furthermore, the procedure of salivary stimulation increased the salivary flow rate which in turn decreases the concentration of S-IgA [20] [21].

In the present study, the measurement of the S-IgA levels was performed using ELISA technique as it is a highly accurate method to detect salivary biomarkers including S-IgA [19].

The use of light-cured resin impregnated E-glass fibres mesh was selected in the study as it eliminates the difficulties in the manipulation of E-glass fibres. Curing of the reinforcing mesh using a light curing unit is another advantage to be considered. Besides, it provides better fracture resistance as supported by previous studies [22] [7].

The findings of the present study revealed that insertion of complete dentures caused a

progressive continuous increase in the S-IgA levels till the end of the follow-up periods in both groups. These findings are by the previous study conducted by Corega et al., 2014 [23], and Youness et al., 2015 [24], who observed that insertion of orthodontic appliances increased the concentration of S-IgA. The apparent increase in the S-IgA could be attributed to two main reasons. The first reason could be due to hyper-salivation and the stress associated with the insertion of the new prostheses [25]. The second could be attributed to the leaching of toxic compounds from an acrylic resin material as residual monomers and plasticizers [26] [27] which, may initiate immunogenic response. However, the present finding is in disagreement with a previous study conducted by wessam et al., who reported that insertion of complete dentures made of different denture base materials, resulted in the decrease of the level of S-Ig A.

Although, the results also demonstrated an increase in S-IgA level in patients wearing reinforced denture bases compared to conventional dentures. The differences were not statistically significant.

Therefore, it could be proposed that denture acrylic resin material rather than E-glass reinforcement mesh may be the main cause for an increased level of S-Ig A in both groups. Furthermore, the increase S-Ig A level in reinforced dentures could be attributed to the impregnation process of glass fibres acrylic resin as reported by Sipahi et al., 2006 [28]. Who mentioned that this requires an increase in the ratio of monomer.

Within the limitation of the present study, it could be concluded that:

1. Insertion of complete dentures constructed from heat cured acrylic resin affects the level of salivary IgA which initiates the immune response.

2. Reinforcement of dentures with light cured resin impregnated E-glass fibres mesh showed no significant differences compared to heat cured acrylic resin. However, further clinical studies for a prolonged follow-up periods are required to detect the possible side effects such as allergic responses and systemic toxicity.

3. Laboratory investigations are also needed to assess cell cytotoxicity.

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