

## THE EFFECT OF TITANIUM DIOXIDE NANOPARTICLES INCORPORATION IN OVERDENTURE ON THE PRESERVATION OF THE GINGIVAL HEALTH OF THE ABUTMENTS

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### ABSTRACT

**Statement of the problem:** Preservation of the gingival health of the abutment is one of the most important factors for overdenture success. Many investigators modify acrylic resin to improve the biocompatibility.

**Objective:** The aim of this study was to assess the effect of Titanium dioxide nanoparticles incorporation in acrylic resin overdenture on the gingival health of the abutment.

**Materials and methods:** Twelve patients with remaining two mandibular canines were selected and divided randomly into two groups. Group 1 patients received Mandibular overdenture constructed with Titanium dioxide nanoparticles incorporated in the acrylic resin. Group 2 patients received mandibular overdenture constructed with conventional acrylic resin. All patients were scheduled for recall visits at 2,4,6 and 8 weeks after delivery. Four points around each abutment were recorded for the plaque index, gingival index and gingival bleeding index.

**Results:** As regards the plaque index scores, gingival index and gingival bleeding index scores there was an increase in both groups of patients. The increase was statistically significant in group 2 and non-significant in group 1.

**Conclusion:** Within the limitations of this study, tooth supported overdenture constructed with acrylic resin with Titanium dioxide nanoparticles strengthened the gingival health of the overdenture abutments than the conventional acrylic resin.

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## INTRODUCTION

Conventional acrylic resin has been generally adopted as a common denture base material [1-3]. Since the 1930s, polymethylmethacrylate (PMMA) is the most common resin used in denture base construction [4]. This is attributed to its mechanical properties, dimensional stability, biocompatibility, excellent aesthetics, low cost and ease of fabrication [5]. Recently, there has been much advancement in the denture base resin field to control and to invent a new denture base resin. Nanoscale titanium dioxide/titanium dioxide nanoparticles (TiO<sub>2</sub> NPs) have received a significant attention due to their ease of availability, strong physical properties, chemical stability, antibacterial activity, and cost-effectiveness [6]. Previous studies showed that the addition of TiO<sub>2</sub> NPs in the PMMA had a wide effect on the reduction the colonization of commensal bacteria than the conventional dentures [1].

In elderly patients 'Oral hygiene measures are difficult to be controlled. Denture plaque is responsible for a diversity of clinical problems, including abutment caries, denture stomatitis and candida-associated denture stomatitis [7]. Seeking for a denture base material with robust antimicrobial properties may provide a solution for geriatric overdenture wearers with limited dexterity (e.g., rheumatoid arthritis, Parkinson disease) [8]. The aim of this study is to assess the effect of titanium dioxide nanoparticles incorporation in acrylic resin overdenture on the gingival health of the abutments.

## MATERIALS AND METHODS

This study is a randomized clinical trial conducted on twelve male patients presented in the outpatient clinic in the Prosthodontic Department, Faculty of Dental Medicine, Cairo University. The study was validated by the research ethical committee of Cairo University.

### Selection of patients

#### Exclusion criteria

1. Patients involved in any systemic diseases as un-

controlled diabetes or consumed medications affecting the gingiva.

2. Patients with Parafunctional habits like clenching or bruxism.
3. Patients having Inadequate oral hygiene level.

#### Inclusion criteria

1. Patients aged from 45 to 60 years old were enrolled in this study.
2. Patients were included if they were required overdentures supported on the remaining bilateral lower canines.
3. Having the two canines free from any preapical pathosis with average of pocket depth no more than 3 mm with grade mobility and bone support not less than 5 mm [9].

### Grouping

Patients were randomly divided into two groups.

Group I	Group II
Group received lower overdenture constructed with Titanium dioxide nanoparticles incorporated in the acrylic resin.	Group received lower overdenture constructed with conventional acrylic resin.

### Canine preparations and overdenture construction

Root canal treatment was made for the canines using the conventional techniques of root canal treatment and amalgam coronal restoration applied, the clinical crown was reduced to the height of 2 mm above the gingival margin taking the final dome-shape (fig.1) [10]. Alginate impressions (cavex Holland bv) for upper and lower ridges were made and poured into stone casts. Acrylic special trays were constructed and used to make an accurate border molded secondary impressions with rubber base impression material. The impressions were poured and master casts were used to construct the bite blocks. Wax wafer method used for recording the centric occluding relation. The trial dentures were

waxed, flaked, finished and polished. The denture was adapted to the prepared abutments by placing pressure indicating paste in the abutment indentation, checked in patient mouth and all pressure area spot were removed <sup>[11]</sup>. The patients of both groups were instructed to take the denture out at night and place it in water, brush the denture after every meal with a soft brush, then brush the abutments after each meal and clean the sulcus with dental floss

### Preparation of the acrylic resin with Titanium dioxide nanoparticles.

TiO<sub>2</sub> NPs were mixed separately with the powder of acrylic resin polymer in an amalgamator for 20 minutes to obtain a mixture with 1wt % TiO<sub>2</sub> content. The mixed solid powder was manually blended with the resin monomer to obtain homogenized mixture which was packed to construct the overdenture (fig.2) <sup>[12]</sup>.

### Follow-up measurements

Measurements were made at 4 points around each abutment for the plaque index (Löe Plaque Index), gingival index (Löe-Silness Gingival Index) and gingival bleeding index <sup>[13]</sup>. All parameters were measured nearly zero plaque index at delivery (base line) two, four, six, and eight weeks after delivery.

### Statistical analysis

The results obtained from plaque, gingival and bleeding indices were reported as the mean values

±SD. Statistical differences were examined using Student's unpaired t-tests. Differences were considered statistically different when  $p < 0.05$ .

### RESULTS

Changes in the plaque index score are presented numerically in table 1 and graphically in figure 3. Both show a gradual increase in the mean plaque index scores in both groups of patients. The increase was less in the first group than in the second group. The increase in the first group was from 0.32 after two weeks. After four weeks, it increased to 0.52 and reached 1.1 after eight weeks. In the second group it increased from 0.38 to 0.62 after two weeks, and to 1.4 after eight weeks, by using student "t" test this difference was statistically significant as shown in the same table.

On the other hand, changes in the gingival index scores were presented numerically in table 2 and graphically in figure 4. In the second group changes of gingival index scores were increased during eight weeks from 0.05 to 1.5 while in the first group it increased from 0.05 to 0.5. The difference between the two groups on gingival index scores were statistically significant throughout the whole experimental period.

The change in bleeding index scores was parallel to the change in the gingival index scores, as shown in figure 5 and table 3.



Fig. (1): prepared abutment.



Fig. (2): fitting surface of overdenture

TABLE (1): Mean and standard deviation values for the Plaque Index Scores during the whole experimental period.

	Base line Mean S.D.	2 Weeks Mean S.D.	4 Weeks Mean S.D.	6 Weeks Mean S.D.	8 Weeks Mean S.D.
<b>Group I</b>	0.32 ± .03	0.334 ± 0.028	0.520 ± 0.028	0.600 ± 0.027	1.1 ± 0.03
<b>Group II</b>	0.38 ± .26	0.622 ± 0.032	0.806 ± 0.049	0.946 ± 0.014	1.4 ± 0.032
<b>t-value</b>		2.6	2.3	3.8	3.9
<b>p-value</b>		*	*	*	*

\*  $p < 0.05$ .

TABLE (2): Mean and standard deviation values for the Gingival Index Scores during the whole experimental period. \*  $p < 0.05$ .

	Base line Mean S.D.	2 Weeks Mean S.D.	4 Weeks Mean S.D.	6 Weeks Mean S.D.	8 Weeks Mean S.D.
<b>Group I</b>	0.02 ± 0.05	0.02 ± 0.05	0.03 ± 0.07	0.02 ± 0.12	0.03 ± 0.5
<b>Group II</b>	0.02 ± 0.05	0.04 ± 0.08	0.04 ± 0.13	0.04 ± 1.3	0.04 ± 1.5
<b>t-value</b>		3.1	2.9	2.9	2.8
<b>p-value</b>		*	*	*	*

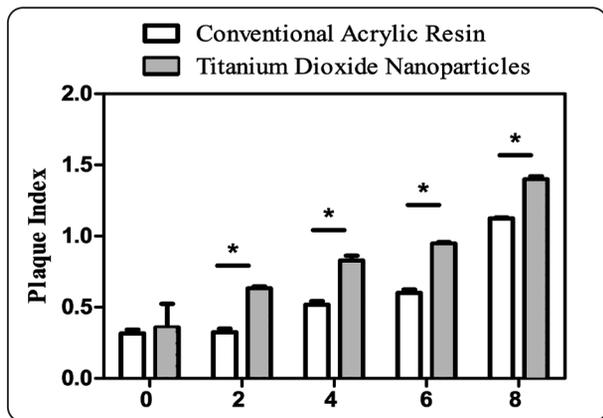


Fig. 3: Plaque indices of Group received lower overdenture with Titanium dioxide nanoparticles incorporated in the acrylic resin (Group I) and Group received lower overdenture constructed with conventional acrylic resin (Group II) during 0, 2, 4, 6, 8 weeks period. A significant increase in the mean plaque index scores in group 2 during 2, 4, 6, 8 weeks. \*  $p < 0.05$ .

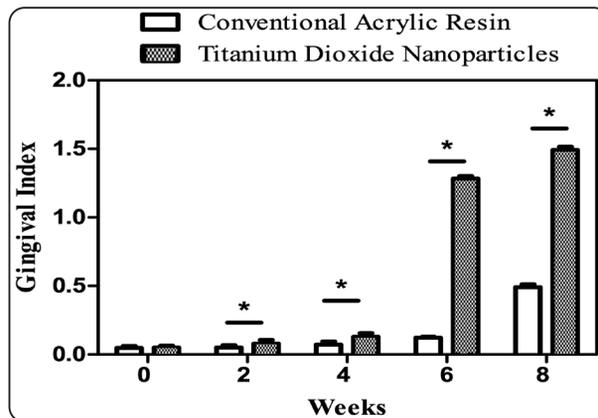


Fig. 4: Gingival indices of Group received lower overdenture with Titanium dioxide nanoparticles incorporated in the acrylic resin (Group I) and Group received lower overdenture constructed with conventional acrylic resin (Group II) during 0, 2, 4, 6, 8 weeks period. A significant decrease in the mean gingival index scores in group 1 during 2, 4, 6, 8 weeks. \*  $p < 0.05$ .

TABLE (3). Mean and standard deviation values for the Gingival bleeding Index scores during the whole experimental period.

	Base line		2 Weeks		4 Weeks		6 Weeks		8 Weeks	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Group I	0	0	0	0	0	0	0	0		
Group II	0	0	0	0	0	0	1	± 5	2	± 7
t-value										3.8
p-value								*		*

\*  $p < 0.05$ .

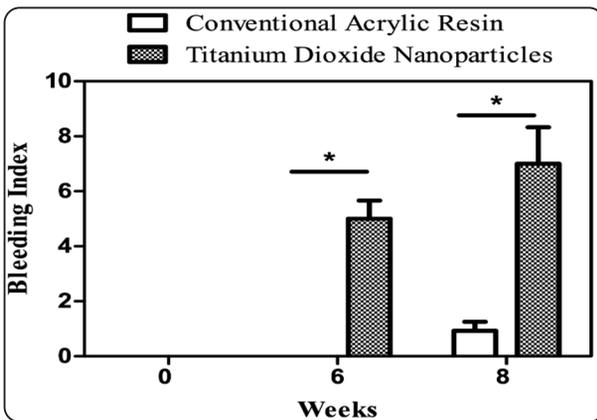


Fig. (5): Gingival bleeding indices of Group received lower overdenture with Titanium dioxide nanoparticles incorporated in the acrylic resin (Group I) and Group received lower overdenture constructed with conventional acrylic resin (Group II) during 0, 6, 8 weeks period. A significant decrease in the mean bleeding index scores in group 1 during 6 and 8 weeks. \*  $p < 0.05$ .

**DISCUSSION**

This study is used to assess the effect of Titanium dioxide nanoparticles incorporation in acrylic resin overdenture on the gingival health of the abutments using the plaque index (Löe Plaque Index), gingival index (Löe-Silness Gingival Index) and gingival bleeding index. The gingival, the plaque, and the bleeding indices results showed statistically significant differences between the group received lower overdenture constructed with Titanium dioxide nanoparticles incorporated in the acrylic resin

(Group I) and the Group received lower overdenture constructed with conventional acrylic resin (Group II).

The oral cavity of the elderly population with or without teeth may be inhabited by bacteria coexisting in the oral flora. Many factors may govern a rise in the number of microorganisms in the mouth, which can improve colonization and allow them to become pathogenic. Among the predisposing factors are the denture-wearing and the poor denture hygiene [14].

Several authors have stressed the safety and environmental friendliness of nanoparticles consisting of TiO<sub>2</sub>. Several attempts have been made to reduce bacterial colonization on the denture base, materials [16]. However, much attention has been pointed toward the incorporation of nanoparticles into PMMA to enhance its properties [17]. Between several nanoparticles ‘constituents, TiO<sub>2</sub> nanoparticles are widely used due to their non-toxic, chemically inert, and little cost, high re-fractive index, antibacterial property under a variety of spectrum, corrosion resistant and high hardness [18].

In the present study, the TiO<sub>2</sub> was used only in the form of 1 wt% according to Moslehifard et al. [19]. The samples of the present study were collected after two, four, six and Eight weeks follow up periods for each group.

TiO<sub>2</sub>NP were found to have an intrinsic antimicrobial property due the production of cytotoxic oxygen radicles [26]. TiO<sub>2</sub>NP are ideal additives because of their nontoxicity and chemical stability. However, under certain conditions they have an antimicrobial ability [20]. TiO<sub>2</sub>NP had the ability to inhibit the adherence of cariogenic bacteria in planktonic phase as well as in later phases of biofilm formation. The addition of TiO<sub>2</sub>NP to PMMA resin used for dentures or other oral appliances will have a positive effect against microbial colonization [21].

Anehosur et al. (2012) found that the addition of 3 wt% TiO<sub>2</sub>NP to PMMA produced a positive antimicrobial effect. It had the ability to reduce microbial number, which prevents quorum sensing thereby halts plaque formation on PMMA/TiO<sub>2</sub> nanocomposite surface [22]. On the same way, Alrahlah et al. (2018) reported a 50% and 90% decrease in bacterial cell attachment of *E. faecalis* and *P. aeruginosa*, respectively, with the mere addition of 3% TiO<sub>2</sub>NP [23]. Likewise, Totu et al. (2017) investigated the effect of incorporating TiO<sub>2</sub>NP into a 3D-printed PMMA denture in an attempt to improve denture antimicrobial characteristics and found that even the small addition of 0.4% of TiO<sub>2</sub>NP to PMMA resulted in a nanocomposite that prevented the colonization of microorganisms and further formation of biofilm [8]. As a result, TiO<sub>2</sub>NP could be incorporated into denture PMMA resin to successfully fabricate antimicrobial dentures [8]. The large active surface area of the nanoparticles compared to their small size makes them highly effective in low percentages of addition. It was found that as low as 0.4%, 1% and 2.5% TiO<sub>2</sub>NP inhibited the growth of *Candida*. As reported previously in the literature, TiO<sub>2</sub>NP caused a halt in the cellular enzymes and increased cell wall permeability causing cell death [24]. Few studies reported that the addition of as much as 5wt% TiO<sub>2</sub>NP to the PMMA is needed to achieve the antimicrobial effect [25]. However, with this addition, structural decomposition and material weakening may occur [26].

## CONCLUSION

within the limitation of this study tooth-supported overdenture constructed with incorporated acrylic resins with 1wt % TiO<sub>2</sub> nanoparticles preserves the gingival health of the abutment more than the conventional acrylic resin.

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