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EVALUATION OF MICROBIAL COLONIZATION IN TWO DIFFERENT MAXILLARY OBTURATOR MATERIALS

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ABSTRACT

Objectives: This study was performed to compare the bacterial and candidal growth in patients wearing maxillary obturators constructed from conventional heat polymerized acrylic resin versus obturators constructed from thermoplastic resin.

Materials and methods: Ten patients were selected with acquired maxillary defects and received two obturators; one was made from conventional heat cured acrylic resin (Group I) and the other was constructed from thermoplastic resin (Group II). The patients were asked to wear every obturator for four weeks followed by a two-week gap before they start wearing the second obturator. At the time of delivery, a swab sample was collected from the mucosa of the defect using a sterile cotton swab to evaluate normal bacterial and candida counts (base line). Another sample was collected from the oral mucosa as well as the fitting bulb of the obturator after one month of insertion.

Results: The conventional acrylic resin group showed higher bacterial and candidal counts than the thermoplastic resin group as well as higher percentages of bacterial and candidal growth.

Conclusion: thermoplastic resin proved to be a good material from the biological aspect for the construction of maxillary obturators for some selected cases.

KEYWORDS: obturators, Bacterial counts, Candida, thermoplastic resin

INTRODUCTION

Prosthetic rehabilitation of acquired maxillary defects have managed to restore both function and appearance thereby greatly improving the quality of life of these patients. The presence of a well-constructed obturator can overcome the oral disabilities resulting from surgical removal of tumors and other acquired defects, such as hypernasality, leakage of food into the nasal cavity, poor mastication and facial deformity [1,2]. Obturators

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are able to provide proper lip and cheek support which enhances the patient's appearance and contributes greatly to patients' prognosis, allowing them to perform their daily functional activities and resume their lives in a normal manner [3–6].

The presence of a maxillary defect results in a communication between the oral and the nasal cavity which exposes the obturator to the microorganisms of both the oral cavity as well as the nose and sinus [7–9]. This altered microflora could aid in the creation of a biofilm with microbial colonization that extends to the surface and infiltrates the interior of the prosthesis. Several studies have confirmed the presence of candida albicans on the mucosa and the surface of oral prostheses [9–13]. The surface characteristics and structural defects of the obturator, such as microporosities, increase the risk for prosthesis-related infections resulting from bacterial and fungal colonization [14–18]. This microbial exposure, in patients with maxillary defects who are often immunocompromised, puts them at a higher risk for the spread of infection that could culminate to systemic infections and hospitalization [7,14,15,19–21].

Polymethyl methacrylate (PMMA) is generally used for construction of obturators for maxillary defects. Some of the commonly known drawbacks of PMMA is the presence of microporosities and residual monomer which results in tissue irritation and increase the chances of fungal and bacterial infections [18,22]. Another major disadvantage is the polymerization shrinkage and release of thermal stresses.

Alternative processing techniques, such as injection molding with the use of thermoplastic materials, have been developed in order to overcome the drawbacks of conventional PMMA. The advantages of such materials include elimination of residual monomer, high dimensional stability, high creep and fatigue resistance, and excellent wear properties. They have been used successfully in the fabrication of a variety of dental and maxillofacial prostheses including removable partial dentures, complete dentures, provisional fixed restorations, sleep apnea appliances, occlusal splints and obturators.

This study aims at comparing the bacterial and candidal growth occurring in obturators manufactured from conventional PMMA and thermoplastic resin.

MATERIALS AND METHODS

Ten patients with acquired maxillary defects (Armani Class I) were selected from the outpatient clinic of the department of removable prosthodontics, Faculty of Dentistry, Cairo University. The selection criteria included male patients between the age of 40 and 60, with a completely healed acquired maxillary defect. The selected patients were free from any systemic disease and not undergoing radiotherapy or chemotherapy or any other medications. Patients were informed with the nature of this research work and their approval was documented with a written consent to ensure cooperation and adherence to treatment protocol and recall appointments.

Detailed medical and dental history and thorough intra-oral examination were performed for all the patients. Any decayed teeth were properly diagnosed, treated and restored, and only unrestorable teeth were extracted. Thorough supra-gingival scaling and root planning were performed followed by intensive motivation towards proper oral hygiene measures. For those patients who showed poor periodontal support of teeth on the intact side, splinted porcelain fused to metal crowns was constructed to avoid early loss of these strategic teeth.

All undesirable undercuts were blocked with vaselinized gauze, and then a primary impression was done using alginate in a modified stock tray for both arches. The final impression for the maxillary arch was done with alginate in a spaced custom tray with stoppers, which was then poured to obtain a master cast. A silicone mold was obtained in order to duplicate the master cast for the construction of the two obturators.

Two weeks before the obturators were delivered, patients were instructed to remove their old obturators during day and night and to only wear them during eating. They were also instructed to use chlorhexidine mouth wash in order to return the oral flora back to normal levels which will be considered the base line count in this study.

Each patient was given two obturators; one was made from conventional heat cured PMMA* (Group I) (Fig. 1A). The second one was constructed from thermoplastic acetal resin** material. (Group II) (Fig. 1B).

For group I, the acrylic resin obturators were constructed using heat cured acrylic resin that was processed using the conventional technique. Retention was obtained using wrought wire clasps engaging the buccal undercuts on both sides. Curing was done at a temperature of 74°C for nine hours (long cycle) before finishing and polishing. Delivery and examination in the patients' mouths were performed for any over extension or occlusal discrepancies (Fig 1A).

For group II, the obturators were constructed from a framework made of thermoplastic nylon material (Acetal resin). This material is supplied in sealed cartridges and injected at a temperature range of 274-293 °C using a special injection-molding machine under pressure. The framework was designed to end before the defect and mechanical perforations were made over the saddle areas and near the defect area in order to facilitate the retention of the thermoplastic material that will extend deeper in to the defect later on. After framework construction, trial insertion was performed inside the patient's mouth to ensure proper seating and retention of the framework. Jaw relation records were done using the wax wafer technique and casts were then mounted on the articulator. Non-anatomic, cross-linked teeth were arranged following the monoplane occlusion guidelines in order to decrease the lateral component of force that might compromise obturator stability and retention. A trial obturator was inspected in the patient's mouth to check occlusion, maximum intercuspation, vertical dimension, as well as palatal and facial contour (Fig 1B).

After the trial insertion of the artificial teeth on the framework, a corrective impression of the defect was performed on the framework using tissue conditioning material *** in order to ensure proper oro-antaral separation, record all the fine details, achieve proper seal as well as to avoid any undue

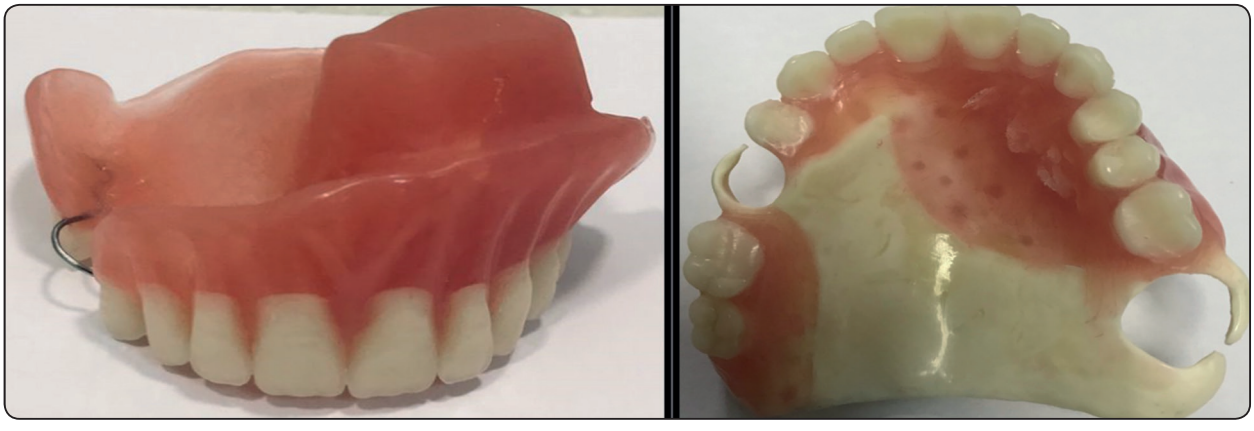

Fig. (1) A: Acrylic resin conventional obturator B: Thermoplastic obturator

* Acrostone, Denture base material, England.
** Thermopress 400 injection machine, thermopress 400injection-molding system, Bredent company, Germany.
*** Dura conditioner Reliance Dental Manufacturing LLC, USA

pressure on the mucosa of the defect. The impression was boxed and poured and all impression material was removed and replaced with injectable resin that was injected in the mold under pressure using a special injection-molding machine. The obturator was finally finished, polished and checked in the patient's mouth and adjusted as needed. In some cases, the fitting surface of the obturator opposing the defect side was perforated to create some mechanical undercuts for the retention of a soft liner if needed for any future refitting.

Each patient had to wear every obturator for one month, followed by a two-week gap period in order to return the oral flora to normal levels (base line). Post insertion instructions were to wear the obturator during daytime and remove it only for six hours to reduce trauma to the underlining mucosa and to avoid any medications or mouth wash other than warm saline so as not to alter the oral flora.

A swab sample was collected from the mucosa of the defect at the time of insertion for each obturator to evaluate normal bacterial and candida counts (base line). Another sample was collected from the oral mucosa as well as the fitting bulb of the obturator using a sterile cotton swab after one month of insertion. Swabs were immersed in tubes containing thioglycolate transport medium and shaken vigorously for one minute to promote microorganism suspension.

Brain heart infusion agar plates and Sabouraud Dextrose Agar (SDA) plates were prepared, heated and boiled, and then left to cool to 40-50 °C before being poured in sterile petri dishes. Swabs were emulsified in 1 ml nutrient broth, and then two serial dilutions were made for each sample. The resulted samples were immediately plated onto Brain heart infusion agar and Sabouraud Dextrose Agar to determine the total number of bacterial and candida colonies respectively.

For cultivation of candida, dishes of Sabouraud Dextrose Agar were covered and incubated for 24 hours at 37°C. For aerobic bacteria, the dishes were covered and incubated in the same previous aerobic conditions. Plates for anerobic bacteria were incubated at 37°C for 48 hours under anerobic conditions. (Fig. 2)

Viable colonies on each petri-dish were counted visually and the estimated number of colony-forming units (CFU) per millimeter square was calculated and recorded and statistically analyzed for each type of bacteria/candida.

Petri dishes for bacterial (aerobic and anaerobic)/ candida growths were examined under the Sterio microscope* in the Research Unit and Dental Supplies, Faculty of Dentistry, Cairo University at magnification x20.

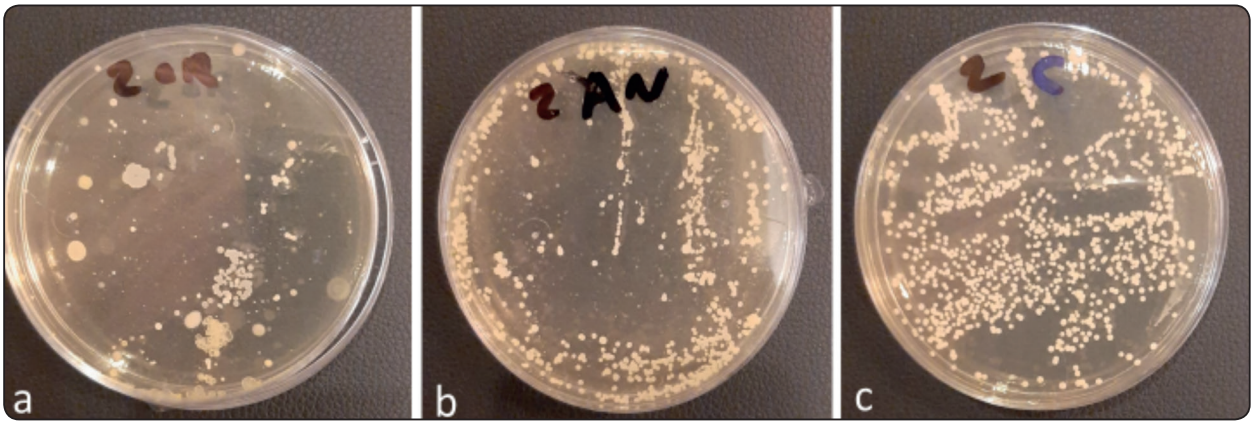

Fig. (2): Petri dishes for cultures for (a) aerobic bacteria (b) anaerobic bacteria and (c) candida

The mean and standard deviation values were calculated for each group in each test. Data was explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests and data showed parametric (normal) distribution. Paired sample t-test was used to compare between two groups in related samples. Independent sample t-test was used to compare between two groups in non-related samples. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

RESULTS

Examination and comparison of bacterial (aerobic and anaerobic) and candidal colonies under the Sterio-microscope throughout the follow up period between the two groups revealed that, there was no statistical significance between the two groups at the base line, where $p \leq 0.05$. On the contrary, a statistically significant difference was monitored between the two groups regarding both the bacterial and candidal growth after one month of follow up. The highest mean value was always found in Group I (conventional PMMA) while the lowest mean value was found in group II (thermoplastic resin). (Table 1, Fig.3,4 &5)

When comparing between the groups regarding the bacterial and candidal percentage of growth (aerobic and anerobic) throughout the follow up period where $p< 0.05$, a statistically significant difference was monitored between the two groups regarding both the bacterial and candidal growth percentages after one month of follow up. The highest mean value was always found in Group I (conventional PMMA) while the lowest mean value was found in group II (thermoplastic resin). (Table 2, Fig.6)

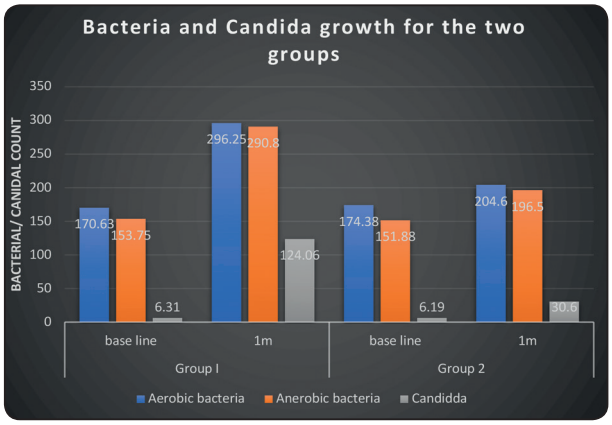

Fig (3): Mean and Standard deviation of Bacteria and Candida growth for the two groups

TABLE (1): Mean and Standard deviation of bacteria and Candida growth for the two groups

Variables	Aerobic Bacteria					Anerobic Bacteria					Candida				
	Group I		Group II		P- value	Group I		Group II		P- value	Group I		Group II		P- value
	Mean	SD	Mean	SD		mean	SD	Mean	SD		mean	SD	Mean	SD	
Base line	170.63	36.05	174.38	54.28	0.41	153.75	36.49	151.9	48.33	0.451	6.31	1.58	6.19	1.83	0.419
After 1 M	296.25	39.03	204.6	46.6	<0.001*	290.8	36.15	196.5	50.13	<0.001*	124.06	6.29	30.6	25.96	<0.001*
P- value	<0.001*		<0.001*			<0.001*		<0.001*			<0.001*		<0.001*		

; Significant (p < 0.05)

* Leica S8AP0, Germany

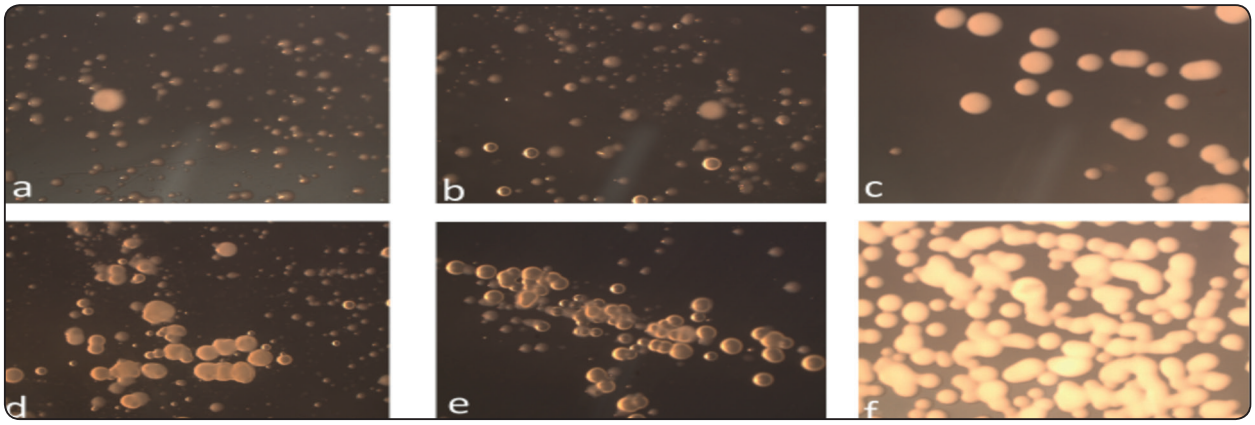

Fig. (4): Photomicrographs of group 1 culture plates for aerobic, anaerobic bacteria and candida at baseline (a,b,c) and after one month (d,e,f) (x20)

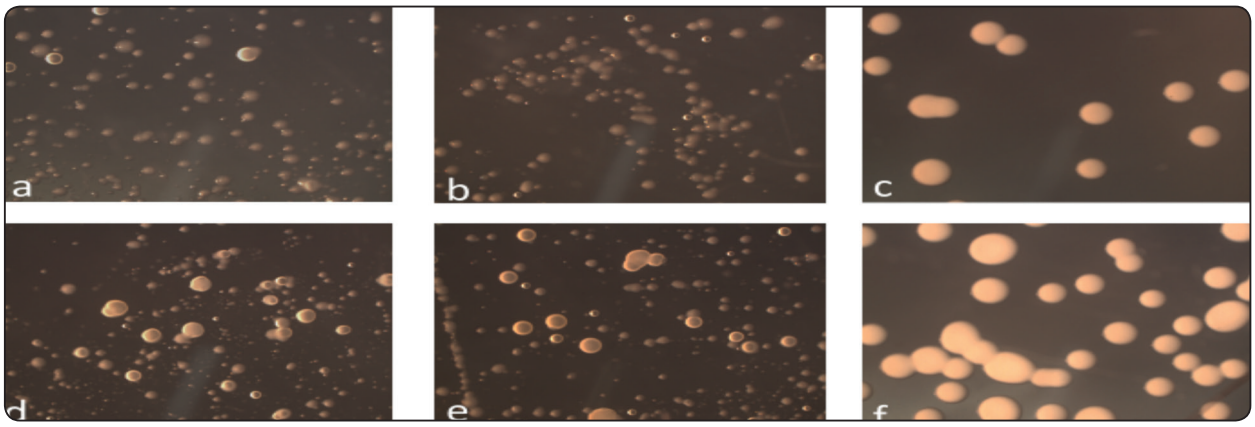

Fig. (5): Photomicrographs of group 2 culture plates for aerobic, anaerobic bacteria and candida at baseline (a,b,c) and after one month (d,e,f) (x20)

TABLE (2): Mean and Standard deviation of bacteria and Candida growth percentages for the two groups

variables	Percentage of growth change					
	Aerobic		Anerobic		Candida	
	mean	SD	Mean	SD	mean	SD
Group I	42.34	6.64	44.33	8.88	78.52	6.65
Group II	27.06	9.2	26.24	8.73	94.69	2.2
P value			**<0.001***			

; Significant (p < 0.05)

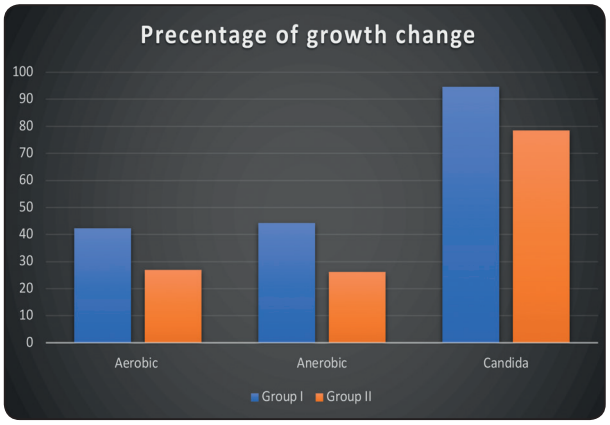

Fig (6): Mean and Standard deviation of Bacteria and Candida growth percentages for the two groups

DISCUSSION

This study was conducted to compare the bacterial and candidal growth and colonization in cases of acquired defects resulting after maxillectomies. Tumor resection will definitely disturb the oral micro flora of the mouth due to the oro-nasal communication that will permit the accumulation of the oral and nasal flora as well as candida colonization on the fitting surface of the obturator. Additionally, the introduction of any prosthetic appliance into the oral cavity will change this bacterial environment as well [23,24].

All patients selected for this study were free from any systemic disease, such as uncontrolled diabetes. They were also not undergoing radiotherapy, chemotherapy or any other medications such as corticosteroids or antibiotics. This was done to avoid any imbalance in the microbial flora. Additionally, some medications might modulate the immune system causing alteration in the oral bacterial/candidal community [25,26].

The results of this study revealed that there was significant increase in the bacterial and candidal colonization counts as well as in the percentages of growth in group I (conventional PMMA) when compared to group II (thermoplastic resin) throughout the follow up period. Furthermore, examination of bacterial and candidal colonies under the Sterio-microscope revealed that after one month, group I showed more numerous and larger sized colonies compared to group II.

These results might be attributed to several factors. Firstly, the insertion of any kind of prosthesis in patients with maxillary resections will result in an obvious alteration in the bacterial flora as the prosthesis itself will alter the cleansing effect of the tongue and saliva in addition to the introduction of the nasal flora due to the oro-nasal communication presented after the resection. This could enlighten the increase in the bacterial /candidal counts in both groups [10–12].

Secondly, the significantly higher values of bacterial/candidal colonization in the conventional acrylic group might be attributed to the toxic effect and microporosities resulting from the presence residual monomer after the polymerization process which is responsible for various degrees of allergic response in addition to tissue trauma that may enhance microbial colonization [6,27].

Over and above, the lack of porosity attained by the thermoplastic resin material in group II will facilitate achieving a smooth, clean and polishable surface which will directly reduce the potential harboring of microorganisms and microbial colonization [28]

Aziz and Amin in 2015 showed that after two months of using thermoplastic denture base materials whether Versacryl or Brefix 2nd edition, the Para keratinization index of the ridge mucosa was found to be less than the conventional heat cured acrylic resin due to the more favorable surface density that did not encourage bacterial accumulation [29]. In accordance to the previous findings, Tolboe et al. in 1987 noticed obvious bacterial accumulation under bridge pontics made from conventional heat cured acrylic resin that resulted in unfavorable keratosis (parakeratosis) and inflammatory reactions [30]

CONCLUSION

Within the limitations of this study, thermoplastic resin proved to be a good material from the biological aspect for the construction of maxillary obturators for some selected cases.

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