Can New Dentures Decrease *Candida* Levels?

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Purpose: The aim of this study was to evaluate the influence of time-course changes and various types of removable dentures on the oral levels of *Candida* species. ***Materials and Methods:*** In this prospective clinical trial, 72 subjects were divided into three groups according to the type of denture replaced: Kennedy Class I or II removable partial dentures (RPDs), Kennedy Class III or IV RPDs, and complete dentures. Whole saliva and biofilm samples from the palate, tongue, dentures, and inner surface of the cheek were obtained and evaluated for *Candida* diversity before the delivery of the new prostheses (baseline) and at 1, 6, and 12 months postdelivery. The results were analyzed using a three-way analysis of variance, followed by a post-hoc Student-Newman-Keuls test. ***Results:*** *Candida* levels decreased after the insertion of the new dentures; however, after 6 months, *Candida* levels were similar to baseline, and complete denture wearers presented higher *Candida* counts than RPD wearers. ***Conclusion:*** The type of denture does not seem to be a decisive factor in *Candida* levels. After 6 months, *Candida* colonization was well established in all types of removable prostheses. Denture replacement alone did not guarantee a decrease in *Candida* levels for more than 6 months. *Int J Prosthodont 2013;26:470–477. doi: 10.11607/ijp.3047*

Oral candidiasis is the most common fungal oral infection diagnosed in humans,[1] with *Candida* species as the primary etiologic agent.[2] High levels of *Candida* are often associated with denture stomatitis, a mucosal infection in tissue in contact with the prosthesis.[3] Although this microorganism is a normal commensal in the mouth,[4] several predisposing factors, such as immunosuppression resulting from the treatment of various diseases, drugs including broad-spectrum antibiotics, and wearing prosthetic appliances, can lead to an overgrowth of *Candida* species[5] and, therefore, the development of oral candidiasis. In particular, among elderly subjects, these predisposing factors are associated with systemic conditions such as malignancies, broad-spectrum antibiotics, xerostomia, dietary factors, diabetes mellitus, and iron and vitamin deficiencies,[6,7] which often lead to severe candidal infections.

The ability of *Candida* species to adhere to and form biofilm on the surfaces of dentures protects these organisms from detachment by shear forces, such as the flushing action of saliva, and from the antifungal proteins in saliva.[8,9] Additionally, the space between the denture and the mucous membrane has a relatively low pH value,[10] which can provide a suitable microenvironment for *Candida* proliferation.[11] The prosthetic environment created by inadequate oral and denture hygiene and continuously wearing dentures is hospitable for an overgrowth of *Candida* species.[12]

Although *C albicans* is considered to be the main pathogen responsible for the development of denture stomatitis,[2,13,14] other non-*albicans* species have been isolated on acrylic resin denture surfaces and oral mucosa.[8,9,15] The discovery of other *Candida* species is significant because they are frequently resistant to commonly used antifungal agents.[8,16] Therefore, candidiasis associated with high levels of these non-*albicans* species is extremely difficult to treat[17] and associated with bloodstream infections with a high mortality rate.[18,19]

Although cross-sectional studies have attempted to establish a relationship between the use of removable dentures and the prevalence of *Candida* species in the oral environment,[6,15,20] the literature contains few

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longitudinal studies supporting this relationship. The aim of this prospective study was to evaluate time-course changes in the oral levels of *Candida* species in patients who underwent prosthetic treatment with complete or removable partial dentures (RPDs).

Materials and Methods

Experimental Design

This prospective study involved a single-blind design (biofilm analyses) in which patients had their removable dentures replaced (complete dentures) or inserted for the first time (RPDs). *Candida* levels were evaluated at four timepoints—baseline and 1, 6, and 12 months postdelivery—at various sites (inner surface of the cheek, hard palate, tongue, dentures, and saliva). Ethical approval was obtained from the Research and Ethics Committee of the Federal University of Pelotas (protocol 040/2006). Patients who met the inclusion criteria were selected from dental clinics run by the Piracicaba Dental School in Brazil and were free to withdraw without justification at any stage of the trial.

Seventy-two patients (mean age, 57.8 y) were divided into three groups according to the type of denture worn: Kennedy Class I or II RPDs (n = 32), Kennedy Class III or IV RPDs (n = 17), and complete dentures (n = 23). Two operators collected all biofilm samples. Each patient received a new pair of removable dentures. Samples were evaluated using specific medium and biochemical tests at baseline and 1, 6, and 12 months after the delivery of the new dentures.

Assessment Procedures

Inclusion and exclusion criteria are listed in Table 1. Stimulated saliva (Parafilm M, American National Can) were collected from each subject for 5 minutes in the morning and 2 hours after the last meal to assess normal stimulated salivary flow rate (> 1 mL/min). The classification for good health included individuals without any systemic disease such as diabetes mellitus or a heart or lung condition. Intraoral devices such as obturator prostheses (for cleft palates) and occlusal appliances (for temporomandibular disorder [TMD] patients) were exclusion criteria. All individuals presenting with TMD (n = 2) wore occlusal appliances, which could provide an additional area for biofilm development and, therefore, insert a bias into the study.

All complete denture wearers had their dentures for more than 5 years and received replacement dentures. Patients who had never worn RPDs before received prostheses for the first time. All patients had similar Gingival Index (GI) scores and socioeconomic status (three times the Brazilian minimum wage, approximately US$1,050). GI scores were the same at baseline because the patients were being treated at a dental school with a strict protocol giving dentures only to patients who either had good oral hygiene or had undergone any necessary periodontal and restorative treatment. The population studied also had similar socioeconomic status because the dental school program through which they are treated is free and gives priority to low-income people. Therefore, study participants had very similar oral status at the beginning of the study.

Table 1 Criteria for Patient Selection

Inclusion criteria	Exclusion criteria
Adults of both sexes	Use of antifungal agents, antiseptic mouthwashes, or any medication or medical condition known to create a predisposition to oral candidosis (eg, diabetes mellitus or iron and vitamin deficiencies)
Complete denture wearers for 5 y	
Need for removable partial denture	
Normal salivary flow rate	Temporomandibular joint disorder (use of an occlusal appliance)
Good health	
Available for follow-up	

At delivery of the removable dentures, baseline saliva and biofilm samples were collected. Each subject received instructions on oral hygiene, which addressed the health maintenance of the remaining teeth (if any) and cleaning of the dentures. Oral hygiene was performed twice a day using dentifrice and a soft toothbrush, and none of the subjects used denture adhesives for retention. In addition, the patients were instructed to wear their prostheses during the day and night (removable partial or complete dentures). At each evaluation, the oral hygiene instructions were repeated, and the patients were asked if they still wore the prostheses at night. No other attempt to control the nocturnal wear of dentures was done.

Two calibrated investigators working independently collected samples at baseline and 1-, 6-, and 12-month evaluations. Each subject was asked to refrain from eating and performing any oral hygiene for 2 hours before the sample collection procedure. Stimulated saliva and biofilm samples (palate, cheek, and tongue) were collected immediately before delivery of the dentures. Volunteers' whole saliva was collected during masticatory stimulation with Parafilm M in an ice-chilled polypropylene tube and then serially diluted in phosphate buffer saline (PBS). For complete denture wearers, biofilm from their older dentures was also collected.

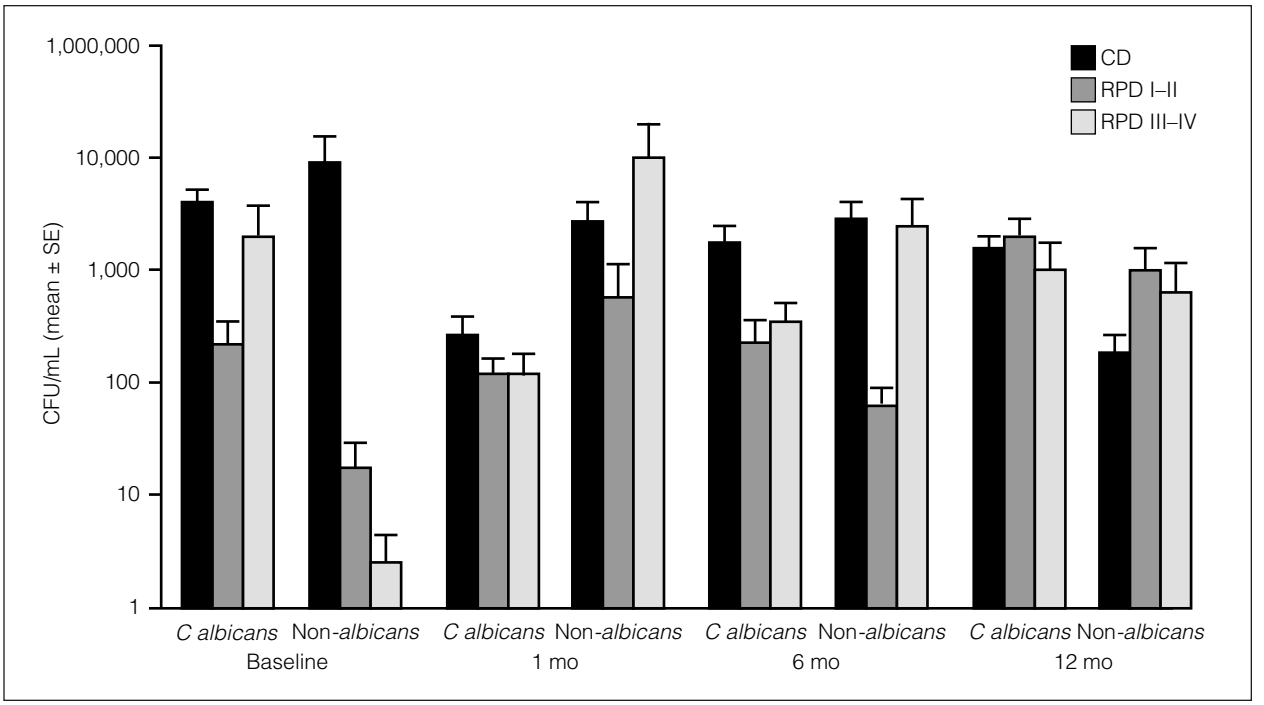

Fig 1 Analysis of type of denture, time of data collection, and *Candida* species for saliva (CD = complete denture; RPD I-II = Kennedy Class I or II removable partial denture; RPD II-IV = Kennedy Class III or IV removable partial denture).

Microbiologic Analysis

Biofilm samples from the tongue, inner surface of the cheek, hard palate, and internal denture surfaces were collected by swabbing the areas for 1 minute. Swabs were inserted in a test tube and sonicated at 30 w with three pulses of 10 seconds in 5 mL PBS. The test tubes containing the saliva samples were individually homogenized in a vortex mixer for 1 minute. All suspensions were serially diluted in PBS, and 20-µl samples were plated in duplicate on CHROMagar *Candida*. Plates were incubated at 37°C under aerobic conditions for 24 to 96 hours. Colony-forming units (CFUs) were counted using a stereomicroscope, and the results expressed in CFU/mL. *Candida* species were identified according to the colony color and biochemical tests and classified as *Candida albicans* or *Candida* non-*albicans*.

Statistical Analysis

Statistical analysis was done using SigmaStat (SigmaStat, version 3.5, Systat Software) employing a significance level fixed at 5%. The null hypothesis assumed no differences among the type of prosthesis, *Candida* species, and timepoint. The data were transformed by rank to fit the assumptions of the equality of variances and normal distribution of errors. The results were analyzed using a three-way analysis of variance followed by a post hoc Student-Newman-Keuls test.

Results

There were no statistically significant differences between the Kennedy Classes I–II and Classes III–IV groups; thus, Tables 2, 3, and 4 show the Kennedy Classes I–II and III–IV groups together. Saliva assessment found no statistically significant differences regardless of the timepoint, type of prosthesis, or *Candida* species ($P = .674$; $P = .112$; $P = .245$, respectively) (Fig 1). On the inner surface of the cheek, complete dentures had the highest counts regardless of timepoint ($P = .005$), and *C albicans* had higher counts than non-*albicans* species regardless of the timepoint and type of prosthesis ($P < .001$) (Tables 2 and 3).

Similarly, on complete dentures, higher counts of *Candida* species were found ($P < .001$), and *C albicans* was more common than non-*albicans* ($P = .005$). However, there was a statistically significant difference among timepoints ($P = .04$), with the baseline and 1-month values presenting higher counts than the 12-month value (Tables 2 and 3).

Table 2 Microbiologic Analysis for *Candida* Species in the Biofilm According to the Experimental Conditions

Type of prosthesis	Cheek		Tongue		Hard palate	
	C albicans[A]	Non-*albicans*[B]	*C albicans*[A]	Non-*albicans*[B]	*C albicans*[A]	Non-*albicans*[B]
Baseline						
CD	13.7 (6.5; 1.0–26.4)*	0.2 (0.1; 0.0-0.4) *	180.5 (79.8; 24.1–336.9)*	136.8 (72.0; –4.4–278.0)*	6.3 (2.4; 1.6–11.0)*	95.0 (61.2; –25.0–215.0)*
RPD I-II	1.2 (0.5; 0.2–2.2)	0.7 (0.4; –0.1–1.5)	4.3 (2.1; 0.2–8.4)	0.5 (0.22; 0.0–1.0)	1.2 (0.9; –0.5–2.9)	0.0 (0; 0–0)
RPD III-IV	0.8 (0.5; –0.2–1.8)	0.5 (0.3; –0.2–1.2)	8.1 (4.0; 0.3–15.9)	0.4 (0.29; -0.2–1.0)	4.8 (4.1; –3.3–12.9)	0.0 (0; 0–0)
1 mo						
CD	0.5 (0.2; 0.2–0.8)*	0.6 (0.3; 0.1–1.1)*	5.4 (2.1; 1.3–9.5)*	58.6 (46.4; –32.3–149.5)*	4.6 (2.6; –0.6–9.8)*	101.8 (64; –23.7–227.3)*
RPD I–II	1.6 (0.7; 0.2–3.0)	1.7 (1.3; –0.9–4.3)	2.2 (0.8; 0.6–3.8)	7.6 (6.55; –5.3–20.5)	0.4 (0.2; 0.1–0.7)	2.0 (1.8; –1.7–5.7)
RPD III-IV	0.4 (0.2; 0.0–0.8)	3.9 (3.2; –2.4–10.2)	2.9 (0.9; 1.0–4.8)	63.9 (47.5; –29.3–157.1)	0.4 (0.2; 0.0–0.8)	32.5 (26.4; –19.3–84.3)
6 mo						
CD	69.3 (53.7; –35.9–174.5)*	1.1 (0.6; –0.2–2.4)*	12.1 (3.3; 5.6–18.6)*	138.6 (72.9; –4.4–281.6)*	3.2 (1.2; 0.7–5.7)*	201.9 (86.1; 33.1–370.7)*
RPD I–II	35.6 (32.8; –28.7–99.9)	0.2 (0.1; 0.0–0.4)	4.9 (1.8; 1.4–8.4)	1.3 (0.6; 0.1–2.5)	1.9 (1.1; –0.2–4.0)	0.5 (0.3; –0.2–1.2)
RPD III-IV	2.2 (1.5; –0.7–5.1)	1.0 (0.9; –0.7–2.7)	61.6 (56.8; –49.8–173.0)	56.1 (57.14; 55.9–168.1)	56.8 (57.1; –55.1–168.7)	55.9 (57.1; –56.1–167.9)
12 mo						
CD	19.6 (4.9; 10.0–29.2)*	3.0 (1.3; 0.5–5.5)*	60.0 (17.3; 26.0–94.0)	31.6 (9.7; 12.5–50.7)	6.6 (1.6; 3.5–9.7)*	2.0 (0.9; 0.2–3.8)*
RPD I–II	17.5 (9.2; –0.6–35.6)	1.0 (0.5; –0.1–2.1)	50.1 (37.5; –23.5–123.7)	11.7 (7.0; –2.1–25.5)	98.0 (51.9; –3.7–199.7)	8.5 (4.6; –0.5–17.5)
RPD III-IV	10.6 (5.5; –0.3–21.5)	0.6 (0.4; –0.1–1.3)	11.4 (5.5; 0.6–22.2)	6.0 (2.3; 1.5–10.5)	2.4 (1.4; –0.5–5.3)	72.6 (64.7; –54.3–199.5)

*Indicates differences among types of dentures.
Values are mean (SE; confidence interval) CFU/mL ($\times 10^2$). Within the same site, upper case letters indicate differences between *Candida* species ($P < .05$). CD = complete denture; RPD I-II = Kennedy Class I or II removable partial denture; RPD II-IV = Kennedy Class III or IV removable partial denture.

Table 3 Percentage of Increased, Decreased, or Maintained Counts According to the Experimental Conditions*

	Cheek			Tongue			Hard palate			Maxillary prosthesis			Mandibular prosthesis		
	Increase	Decrease	Equal	Increase	Decrease	Equal	Increase	Decrease	Equal	Increase	Decrease	Equal	Increase	Decrease	Equal
CD															
1 mo	20/25	45/5	35/70	15/15	50/30	35/55	10/15	40/20	50/65	10/40	40/10	50/50	10/30	65/15	25/55
6 mo	33/20	20/13	47/67	53/49	7/20	40/40	27/13	27/13	46/74	13/13	13/33	74/54	53/7	0/27	47/66
12 mo	80/40	0/0	20/60	80/40	0/40	20/20	60/20	20/20	20/60	40/40	20/20	40/40	40/40	0/0	60/60
RPD I–II															
1 mo	21/14	24/7	55/79	21/28	31/21	48/51	14/7	14/3	72/90	56/17	0/0	44/83	16/20	0/0	84/80
6 mo	17/3	12/21	71/76	25/21	29/25	46/54	17/12	12/8	71/80	60/20	15/10	25/70	35/22	4/4	61/74
12 mo	33/19	10/5	57/76	48/38	10/5	42/57	29/14	14/10	57/76	25/31	19/19	56/50	35/40	10/15	55/45
RPD III-IV															
1 mo	12/12	24/12	64/76	24/18	35/12	41/70	0/12	29/0	71/88	47/27	0/0	53/73	13/19	0/0	87/81
6 mo	17/11	0/6	83/83	39/17	17/6	44/77	28/17	6/6	66/77	56/38	6/6	38/56	33/33	7/13	60/54
12 mo	29/14	21/14	50/72	36/50	21/14	43/36	14/7	29/7	57/86	33/25	17/33	50/42	31/46	8/8	61/46

*Values are *albicans*/non-*albicans* species.
CD = complete denture; RPD I-II = Kennedy Class I or II removable partial denture; RPD II-IV = Kennedy Class III or IV removable partial denture.

The hard palate showed statistically significant differences among timepoint, type of prosthesis, and *Candida* species. The hard palate had higher levels of *Candida* species at the delivery of the new dentures, which decreased 1 month after delivery but increased after 6 and 12 months. Complete dentures ($P < .001$), non-*albicans* species ($P = .002$), and the 6- to 12-month follow-up evaluations ($P = .006$) presented the highest values (Tables 2 and 3).

Table 4 Microbiologic Analysis for *Candida* Species in the Biofilm

Type of prosthesis	Mandibular prosthesis		Maxillary prosthesis	
	C albicans	Non-*albicans*	*C albicans*	Non-*albicans*
Baseline				
CD	398.1 (102.9; 196.3–599.9)^{Aa}	89.3 (59.9; –28.2–206.8)^{Aa}	576.9 (103.1; 374.8–779.0)^{Aa}	90.4 (59.9; –27.1–207.9)^{Aa}
RPD I–II	0 (0; 0–0)^{ACb}	0 (0; 0–0)^{ACb}	0 (0; 0–0)^{Aa}	0 (0; 0–0)^{Aa}
RPD III–IV	0 (0; 0–0)^{Aab}	0 (0; 0–0)^{Aab}	0 (0; 0–0)^{Aa}	0 (0; 0–0)^{Aa}
1 mo				
CD	51.1 (46.6; –40.2–142.4)^{Aa}	54.4 (46.5; –36.7–145.5)^{Aa}	351.9 (101.7; 152.5–551.3)^{Aa}	304.3 (118.7; 71.7–536.9)^{Aa}
RPD I-II	0.6 (0.2; 0.1–1.1)^{Bb}	18.8 (11.3; –3.3–40.9)^{Bb}	98.6 (46.3; 7.8–189.4)^{Ba}	1.1 (0.5; 0.0–2.2)^{Ba}
RPD III-IV	24.1 (22.8; –20.6–68.8)^{Bc}	17.6 (15.3; –12.4–47.6)^{Bc}	26.5 (13.6; –0.3–53.3)^{BCa}	5.2 (4.5; –3.7–14.1)^{BCa}
6 mo				
CD	467.7 (107.5; 257.1–678.3)^{ABa}	2.5 (1.9; –1.2–6.2)^{ABa}	467.9 (107.4; 257.3–678.5)^{Aa}	203.5 (86.0; 35.0–372.0)^{Aa}
RPD I-II	177.1 (68.3; 43.3–310.9)^{Cb}	18.9 (23.9; –28.0–65.8)^{Cb}	294.7 (80.9; 136.2–453.2)^{Ab}	49.2 (39.4; –28.0–126.4)^{Ab}
RPD III-IV	137.7 (85.0; –28.8–304.2)^{Bc}	1 (0.5; 0.1–1.9)^{Bc}	316.2 (115.5; 89.8–542.6)^{BCc}	128.9 (85.1; –38.0–295.8)^{BCc}
12 mo				
CD	492.4 (103.4; 289.6–695.2)^{Ba}	201 (93.1; 18.4–383.6)^{Ca}	327.2 (88.5; 153.6–500.8)^{Ba}	7.2 (2.2; 2.8–11.6)^{Ba}
RPD I-II	258 (77.8; 105.5–410.5)^{Ba}	112 (54.1; 6.0–218.0)^{Ca}	564.1 (90.2; 387.2–741.0)^{Ab}	71.7 (44; –14.5–157.9)^{Ab}
RPD III-IV	310.5 (116.1; 83.0–538.0)^{Ca}	3.9 (1.9; 0.2–7.6)^{Ca}	588.3 (123.4; 346.3–830.3)^{ACab}	6.8 (3.5; –0.1–13.7)^{ACab}

Values are mean (SE; confidence interval) CFU/mL (x 10^2). Capitalized letters represent differences among timepoints within the same type of prosthesis; lowercase letters represent statistically significant differences among the types of prosthesis at the same timepoint. CD = complete denture; RPD I-II = Kennedy Class I or II removable partial denture; RPD II-IV = Kennedy Class III or IV removable partial denture.

For the mandibular prostheses, only complete denture wearers showed statistically significant differences between *Candida* species ($P < .001$). In addition, complete denture wearers had higher levels of *C albicans* than the RPD groups ($P < .001$). That trend did not occur with non-*albicans* species ($P > .05$, Tables 3 and 4). For the maxillary prostheses, statistical analysis revealed the interaction among the three variables tested ($P = .024$) (Tables 3 and 4). At the *C albicans* level ($P = .003$), there was a significant difference associated with the interaction of the timepoint and type of denture; complete dentures and Kennedy Class I and II RPDs had higher counts than Kennedy Class III and IV. Complete denture wearers had a statistically significant difference among timepoints for *C albicans* ($P < .001$), with baseline values differing among timepoints. A similar trend occurred in the Kennedy Classes III–IV RPD group; *C albicans* levels were highest at 6 months and decreased after 12 months ($P < .001$). For all denture types, baseline values of non-*albicans* species were higher at 1 month ($P = .003$), then decreased after 12 months ($P = .011$).

Discussion

This study showed that the location of sample collection plays a key role in the analysis of biofilm because the six sites assessed had different outcomes for the variables evaluated. However, the results of this study cannot be extrapolated for all types of prostheses in all sites presented. Another limitation of this study is that with a larger sample size (more than 1,000 subjects), a multivariate analysis considering data dependence could have been performed, yielding more complete results. This project could be the subject of future research. For a better understanding of *Candida* colonization in oral environments, it is important to assess all variables potentially involved in the process. This study also contributes to the growing evidence that more than one *Candida* species may simultaneously colonize oral habitats.[21] Generally, in this study, *Candida* species simultaneously colonized the biofilm collected from the various sites of the oral cavity.

Saliva has a regulating role in inhibiting the adherence of *Candida* species.[6] Unsurprisingly, especially

considering that the study participants were healthy, the present results showed no difference in saliva counts among the evaluated variables. Possibly, this occurred because anti-*Candida* salivary components and innate defense mechanisms, such as the flushing effect of saliva, affect *Candida* physiology and decrease *Candida* adherence to oral surfaces.[22] This result is in accordance with other studies showing that the *Candida* count decreased when individuals with hyposalivation and high *Candida* levels received salivary stimulation,[23] indicating that low salivary flow rates are associated with higher oral *Candida* counts,[24] not because of the amount of *Candida* but because of the cleaning effect. Although complete denture wearers had the highest amount of *C albicans* species in the inner surface of the cheek, this site also had the lowest *Candida* counts. This seeming discrepancy could be explained by the fact that the inner surface of the cheek is constantly in a state of attrition, modifying the biofilm and making *Candida* colonization more difficult.

While systemic host factors such as diabetes mellitus, HIV infections, iron deficiencies, hypoendocrine states, blood disorders, drug therapies, or xerostomia could create a predisposition to denture stomatitis, the participants in this study were comparable because the host factors that potentially could create differences among them were controlled. In addition, giving all participants instructions in the same oral hygiene procedures assessed whether the new denture alone could bring any benefit to patients positive for *Candida*. Special emphasis was placed on oral hygiene because microbial accumulation on the dentures is known as a potential problem. The surface roughness and concentration of exotoxins and metabolic products caused by fungal growth on the prosthesis destroy the surface quality and can irritate oral tissues. In clinical terms, the surface of an old denture (highly roughened) could facilitate colonization by microorganisms and acid production, mainly by yeasts, which have been identified as major etiologic factors in denture stomatitis. The participants' similarities could be considered a limitation of this study, however, as the findings are applicable only to healthy individuals.

Previous studies showed that a maxillary denture, or hard palate, encloses specific microorganisms in its base, creating a local microenvironment suitable for yeast adhesion and growth, depending more on local factors than individual variations.[25,26] In addition, the denture's surface roughness directly influences microorganisms' initial adherence to surfaces, biofilm development, and *Candida* species colonization.[27,28] The high levels of *Candida* at baseline in complete denture wearers could be attributable to the roughness of the tongue. All patients had worn their older dentures for a long time, so tongue roughness still reflects the old denture's bacterial species. This study demonstrated that after 6 months, complete denture wearers had higher *Candida* counts than RPD wearers, demonstrating the importance of oral hygiene for denture wearers. All subjects enrolled in the study were asked not to remove the prosthesis at night. Although in many countries denture wearers customarily remove their dentures at night, the individuals in this study did not for several reasons: many patients kept their denture use a secret from their families and, most importantly, the practice had already been part of their routine for many years. Thus, all patients would show compliance with the study simply by maintaining their day-by-day routine, including sleeping with a prosthesis. In addition, it has been shown that instructions and motivations about denture hygiene are the most important issues with which patients are concerned.[29] At the study's follow-up evaluations, all patients reported that they used their dentures both day and night, only removing them for cleaning. The question prompted most of the study participants to ask if they should have been removing the dentures, which is a good indication that they were wearing the dentures at night. The findings on nocturnal wear, though, are based solely on the participants' answers.

Asymptomatic oral carriage of *Candida* has been recognized for many years. As the elderly population, and therefore their need for dental treatment, is rapidly growing, [30] studies on their oral hygiene[31] are becoming increasingly important. In a recent cross-sectional study, Zaremba et al[15] showed that *C albicans* is found more often in denture-wearing than nondenture-wearing edentulous individuals. This research corroborates the findings of this study that the dentures of all patients were colonized, especially complete denture wearers who had higher *Candida* levels than RPD wearers. The type of material used in these prostheses could explain these findings. While complete dentures are fabricated with heat-cured acrylic resin, RPDs also contain metal, which sometimes decreases fungal growth.[26] In addition, it is important to point out that complete dentures have a larger area of heat-cured acrylic resin than RPDs, which allows a larger area to be colonized by microorganisms and, consequently, could lead to higher *Candida* levels.

It is important to emphasize that 1 month after the prosthesis delivery, in general, the level of yeast had decreased, followed by an increase to the initial levels (or even higher) after 6 months. The literature showed an association between oral candidiasis and the duration of denture wear,[21] and this study demonstrated

that the regular replacement of a prosthesis does not guarantee a lack of *Candida* colonization even for a short period of time. It is important to highlight the limitation imposed on this study by evaluating two distinct populations: complete denture wearers who already used dentures and RPD wearers receiving dentures for the first time. Therefore, it was impossible to know how the latter would respond to the new RPDs since the complete denture wearers had baseline *Candida* values for the old dentures. Second, although Kennedy Class I dentures might be expected to have a higher volume of acrylic resin than Class II dentures, no statistically significant difference was found between the two groups, which is why they were grouped together in the tables. This finding could have occurred because the volume of acrylic resin is more important when dealing with complete dentures, which cover the palate, preventing the cleansing action of the tongue and saliva. The mere presence of *Candida* in the oral environment does not mean that an individual necessarily has or will develop *Candida*-related pathologies, which depend on complex fungi-bacteria-host interaction that modulates the host's response, possibly leading to inflammation. Nevertheless, if a slight inflammation is not controlled and plaque accumulation continues, this neglect could have a detrimental impact on the patient's health. Moreover, as a result of their large size, fungi contribute more mass to the biofilm than bacteria.[32] According to the ecologic plaque hypothesis,[33] the proportions of pathogenic microorganisms, not the presence of any particular species, dictates the changes that transform health into disease. This theory highlights the need for effective, physical removal of denture plaque, which can be accomplished by regular chemical cleansing (eg, immersion in a sodium hypochlorite solution).

Conclusion

Within the limitations of this study design, it can be concluded that complete denture wearers have a higher count of *Candida* species than RPD wearers and, therefore, should be treated with more caution. Moreover, the type of RPD does not seem to be a decisive factor in *Candida* levels, and after 6 months, *Candida* colonization is well established in all types of prostheses.

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Literature Abstract

Long-term clinical outcome analysis of poly-methyl-methacrylate cranioplasty for large skull defects

This retrospective study aimed to analyze the effect of poly-methyl-methacrylate (PMMA) cranioplasty used for skull defect reconstruction, usually after trauma (64%). Seventy consecutive patients with 78 cranioplasties placed from 2007 to 2010 were selected. A thorough medical record including: the mechanism of injury, location of cranioplasty, type of original repair, complications postoperatively, and follow-up time were reviewed. The same maxillofacial prosthetic technician fabricated all 78 acrylic cranioplasties. Out of the 70 patients reviewed in the study, there were 6 failures. These patients had their original PMMA cranioplasty removed and reinserted. Out of these 6 patients, there were 2 reinsertions, resulting in a total of 78 cranioplasties. The most common complication was chronic pain (14%). Nine out of 70 patients experienced postoperative infection (13%), with the main isolated organism from infected cranioplasties being staphylococcus aureus (67%). The overall complication rate (24%) obtained was comparable to other acrylic cranioplasties studies, as well as studies with the use of autogenous bone. In conclusion, PMMA cranioplasty is safe, cost effective, esthetically acceptable, and with similar complication rates compared to autogenous bone.

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