



Status of Removable Dentures and Relationship with Oral *Candida*-Associated Factors in a Geriatric Population in Catalonia

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The percentage of partial or total edentulism among the elderly exceeds 70% in most countries.¹⁻⁴ Despite the decreased prevalence of edentulism, decreased incidence of tooth loss in Europe and other developed countries, and an increasing interest in oral implants, the vast majority of people with complete or

Abstract

Purpose: Colonization by *Candida* is related to wearing a denture. How denture type, status, and maintenance play a role in determining *Candida* colonization remains unknown. This work evaluated removable denture status in an elderly population and explored the association between denture-related factors and oral *Candida* colonization as determined by systemic and local factors.

Materials and Methods: Socio-demographic, general health, and behavioral data and oral factors were registered by means of a questionnaire. Oral, dental, and denture-related factors were assessed by clinical examination, and yeasts were isolated from oral and denture specimens. Multiple logistic regression analysis was used to explore the relative relevance of risk factors.

Results: Overall, 52.4% of subjects used complete dentures in both lower and upper arches, and 90% of the prostheses were in good condition. Denture plaque index was high in most cases, and 75% of subjects had yeasts in their oral cavities. Oral *Candida* colonization was significantly associated with low saliva pH, sugar consumption, and the fault of a denture component; however, only sugar consumption was found to be an independent factor related with oral *Candida* colonization, showing an odds ratio of 3.04 in a multiple logistic regression model.

Conclusions: Elderly people in this study used a complete denture in good condition, with a median age of 15 years. Daily or weekly sugar consumption was found to be highly associated with oral colonization by *Candida*.

partial edentulism continue to receive conventional prosthodontic treatment.⁵ Studies were carried out in several countries and reported the most frequent weakness is inadequate retention of mandibular complete dentures.^{1,6} Although in many cases the prosthesis used by this population group presents acceptable

occlusion and integrity,⁴ the elderly seldom visit the dentist even though their dentures are often old and may require repair.¹ Therefore, the criteria determining the need for denture repair may be dentist or patient centered.

Restoration with removable dentures has a positive effect on subjective oral health when most natural teeth are missing.⁷ Nevertheless, complications such as dental caries, periodontal disease, oral mucosal lesions, and *Candida* colonization are relatively frequent among denture wearers.^{8,9} The presence of oral *Candida* occurs in 6.5% to 59% of elderly persons,⁹⁻¹¹ and few articles have studied the prevalence of *Candida* in the Spanish elderly population.¹⁰

It has been reported that the prevalence of oral yeasts is unrelated to dry mouth sensation, burning mouth, or taste disorders.⁹ However, oral candidiasis does appear to be related to malnutrition and leads to mucosal lesions that can have a negative impact on food intake, which may subsequently worsen nutritional status.¹² Several systemic, local, and denture-related characteristics are independent risk factors for denture-related mucosal lesions among elderly people.⁸ In addition, researchers have noted several systemic (drug history and systemic diseases¹²), local (poor oral hygiene,^{12,13} denture stomatitis^{13,14}), and denture (wearing denture,^{12,15} daily use frequency,^{13,14} reduced vertical dimension,¹⁴ years of use,^{14,16} resin surface roughness^{17,18}) properties as related risk factors for *Candida* colonization of oral mucosa.¹² However, the association between denture-related factors (like denture type, status, and maintenance) and *Candida* colonization remains unknown.^{9,14} If the presence of *Candida* is associated with denture-related factors, repairing these dentures could be justified to prevent *Candida* colonization.

The aims of this study were: (i) to establish removable denture status in an elderly population in Catalonia (Spain) and (ii) to determine the relationship between denture-related factors and oral *Candida* colonization controlled by systemic and local factors among this population.

Materials and methods

The population for this cross-sectional study consisted of denture wearers living in Catalonia, NE Spain, and aged 60 years or over, who had participated in a previous study.⁸ They either lived in nursing homes (institutionalized) or regularly attended a day-care center for the elderly (non-institutionalized). All subjects wore at least one removable denture, none were under antifungal treatment, and all were cognitively capable of responding to a questionnaire. All subjects provided written informed consent approved by the local ethics committee (Code 07/09). Data were collected from the subjects by means of a questionnaire-based interview, a clinical examination, and complementary tests (Table 1). One hundred and two subjects were interviewed using a questionnaire that included socio-demographic data, general health and behavioral data, information about the oral cavity, and local and denture-related factors.

In the clinical examination, any soft tissue covering the alveolar bone was evaluated, considered firm if the tissue was stable or slightly moveable, and considered not firm if the soft tissue crest was moveable.¹⁹ The denture type, material, and integrity

(lack or breakage of any denture component) were determined by inspection. The occlusal vertical dimension (OVD) was considered reduced when the difference between mandibular rest position and intercuspal position was more than 4 mm in the incisor area.²⁰ Occluding tooth pairs, defined as pairs of maxillary and mandibular teeth at intercuspal position,⁶ were recorded using a 200 μm articulating paper. Occlusal support was assessed using the Eichner index, and the type of dynamic occlusion was also evaluated.²¹ Denture retention was considered good when it was extremely or moderately difficult to break the peripheral seal.¹⁹ Stability was assessed in a similar way to retention but applying a rotational force, and classified as good if there was little or no movement of the denture.¹⁹

Finally, denture plaque index was evaluated (poor or regular/excellent) using erythrosine (Reveal; Henry-Schein, Melville, NY).²² Unstimulated saliva was collected using two dental cotton rolls placed bilaterally under the tongue for 1 minute. The cotton was weighed before and after being placed in oral cavity, and unstimulated saliva flow rates were calculated in ml/min. Saliva pH was measured using pH paper strips (Macherey-Nagel GmbH & Co., Düren, Germany). Oral rinse specimens were obtained from all subjects. In addition, their dentures were placed inside a sterile jar with 100 ml of physiological serum and sonicated for 2 minutes (Ultrasonic Cleaner UCI-50; Raypa SL, Barcelona, Spain). Yeasts were isolated from the clinical specimens by spreading them onto dextrose Sabouraud agar plates. They were incubated at 37°C in aerobic conditions for 48 hours, and then examined. Each colony type was counted, and the number of colony-forming units/ml (cfu/ml) calculated. The specimen was considered *Candida*-infected when the score was at least 20 cfu/ml. All tests were performed in the morning, and subjects were requested not to consume food or beverages or smoke for 1 hour before beginning the tests.

For participants with dentures for both jaws, an average ratio of the denture-related variables was calculated prior to analysis. Bivariate relationships between presence of oral *Candida* and the different variables were examined with the Student's t-test, the Mann-Whitney U-test, or chi-square test, as appropriate. Potential risk factors were selected either because they showed a significant relationship in the bivariate analysis or because they had been reported as significant in other studies. Multiple logistic regression was used to explore the relative importance of the risk factors for presence of oral *Candida* as the outcome variable (forward selection strategy by using the likelihood ratio statistic). Statistical analysis was performed using statistical software (PASW Statistics 21; SPSS Inc, Chicago, IL) ($\alpha = 0.05$).

Results

Of the 102 subjects invited to participate in this study, 10 were excluded because they did not wear dentures regularly, 6 due to a lack of key data, and 2 because they were receiving antifungal treatment. Therefore, 84 subjects were included in the study, 60 of whom were recruited from 7 geriatric nursing homes while the remaining 24 were recruited from 3 day-care centers for the elderly. The median age was 83.7 years, and 75% of the participants were women. Fifty-three subjects (63%) were totally

Table 1 Questionnaire data, clinical examination, and complementary test

	Questionnaire	Clinical examination	Complementary test
Socio-demographic aspects	<ul style="list-style-type: none"> • Age • Gender • Institutionalized (Yes/No) 		
Oral and general behavior	<ul style="list-style-type: none"> • Sugar consumption: (daily-weekly or monthly-never) • Alcohol consumption: (g. Ethanol/day) • Smoker (number cigarettes/day): ex-smoker / never smoked • Brushing frequency • Time since last visit to the dentist 	<ul style="list-style-type: none"> • Quality of soft tissue • Occlusal pairs 	<ul style="list-style-type: none"> • Salivary flow • Salivary pH • Oral <i>Candida</i>
Denture factors	<ul style="list-style-type: none"> • Comfort • Masticatory ability • Current denture age • Nocturnal wear 	<ul style="list-style-type: none"> • Occlusal support • Dynamic occlusion • Type (partial/complete) • Material (acrylic/metal) • Integrity • Occlusal vertical dimension (normal/reduced) • Denture retention • Denture stability 	<ul style="list-style-type: none"> • Denture <i>Candida</i>

Table 2 Denture status distribution

Dentures		Maxillary denture, n (%)	Mandibular denture, n (%)
Type	Complete	59 (70%)	49 (58%)
	Partial metal	13 (15%)	15 (18%)
	Partial acrylic	9 (11%)	7 (8%)
	Any	3 (4%)	13 (16%)
Integrity	Good	72 (89%)	65 (92%)
	Bad	9 (11%)	6 (8%)
Stability	Good	57 (71%)	36 (51%)
	Bad	23 (29%)	35 (49%)
Retention	Good	59 (74%)	24 (34%)
	Bad	21 (26%)	47 (66%)

edentulous and the remaining 31 (37%) were partially edentulous, of which only four had 20 or more teeth; 52.4% were maxillary and mandibular complete denture wearers. Eight subjects were edentulous only in the upper arch, and 5 only in the lower arch. Nine (10.7%) subjects did not wear any inferior prosthesis, despite lower arch edentulism or no lower posterior support.

The subjects' denture status is shown in Table 2. Professional inspection of the prostheses found that 89% of maxillary dentures and 92% of mandibular dentures showed integrity, thus 90% of the prostheses were in good condition. Among dentures that had defects, 14 presented lack or breakage of some ele-

ments. Denture stability and retention was worse in mandibular dentures than in maxillary dentures. The median age of both maxillary and mandibular prostheses was 15 years. Most subjects reported self-perceived comfort with their dentures (88%), and masticatory performance was good or excellent in most cases.

The OVD was reduced in 39% of subjects (Fig 1). Occlusal support with dentures was excellent in most cases, since 81% of subjects had an A1 Eichner index, and dynamic occlusion was bilateral balanced occlusion or group function in 81% of subjects.

Thirty nine percent of subjects reported not visiting the dentist in the last 10 years. Nocturnal denture use was reported by 29%; 8.3% brushed their palate regularly. Sixty six percent brushed the prosthesis once or twice a day, but the denture plaque index was high in most cases, mainly in mandibular dentures (Fig 2). Mouthwash was used by 34% of subjects, and the most frequently used was hexetidine.

It was feasible to isolate yeasts from the oral cavities of 75% of subjects. Of 81 maxillary dentures, 85% proved to be colonized by yeasts; of 75 mandibular dentures 85% had also been colonized. The logarithm cfu/ml for *Candida* in the oral cavity was significantly correlated with the logarithm of cfu/ml for *Candida* in both maxillary and mandibular dentures ($r = 0.81$ Pearson's correlation coefficient) (Fig 3).

Oral *Candida* colonization was significantly associated with low saliva pH, sugar consumption, and lack or breakage of some denture component. No significant association was found between oral colonization and the remaining systemic, local,

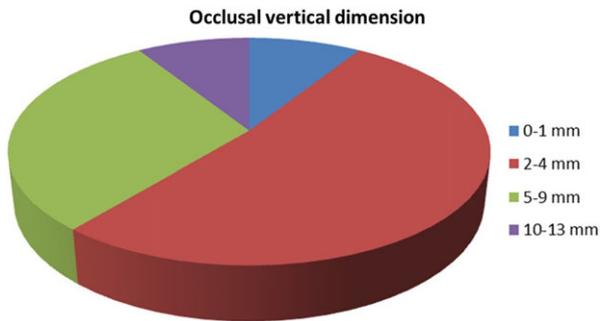


Figure 1 The OVD was considered as the difference between mandibular rest position and intercuspal position (n = 84).

and denture-related variables. Multiple logistic regression was performed with oral *Candida* presence as the dependent variable, to determine the independent contribution of the three factors significantly associated with oral colonization. As a result, daily or weekly sugar consumption was found to be an independent factor determining oral *Candida* colonization (Odds Ratio: 3.04; $p = 0.03$).

Discussion

This study found that 88% of the participants rated their dentures comfortable and scored their masticatory performance good or excellent, although most subjects were still using the same dentures for more than 10 years. In multiple regression model analysis, only sugar consumption was found to be an independent factor associated with oral *Candida* colonization.

Most of the elderly subjects in this study used complete maxillary and mandibular dentures. This finding agrees with an other study conducted among populations of similar age and residential situations.²³ Other studies have observed a higher proportion of partial prostheses rather than complete,²⁴ but in these cases the populations studied were younger individuals, and the proportion of using complete dentures increases with age.²⁵ In this study, the median age of the prostheses was 15 years, which agrees with the results of a German report.²⁶ The prevalence of discomfort experienced with dentures was very similar to that observed in a population of denture wearers in Madrid.²⁷ Despite the longevity of the prostheses, subjective masticatory efficiency was good in most cases, which perhaps

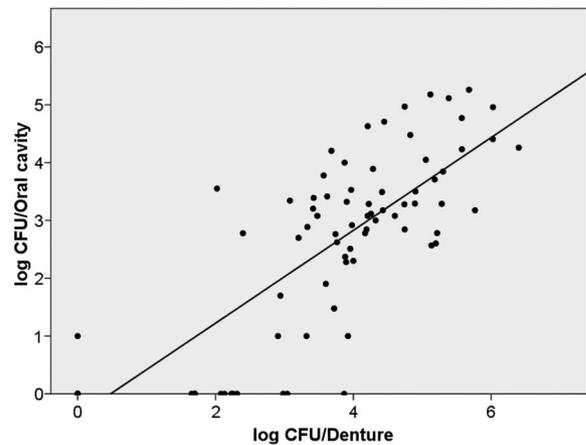


Figure 3 Correlation between *Candida* CFU/ml in the oral cavity and *Candida* CFU/ml on denture.

confirms that the use of prostheses improves patients' quality of life.²⁸

It has been reported that the most frequent errors in the fabrication of a removable prosthesis are overextension of the base and poor intermaxillary horizontal relation; less frequent errors include incorrect vertical dimension and poor palatal seal.²⁹ However, in this study, most of the prostheses had correct vertical dimensions and intermaxillary horizontal relations, possibly because the prostheses had been used for many years, and these problems are usually detected and solved shortly after placement given that, if this does not happen, the patient will probably reject the prosthesis. One of the most common problems with dentures is a lack of retention and stability, particularly in mandibular complete dentures,³⁰ as confirmed in this study. Furthermore, it has been reported that the most frequently performed denture modification is complete relining to enhance fit and stability.²⁶ This study found that lower arch prostheses presented worse stability, and that these more unstable prostheses were significantly older, although this did not affect subjective masticatory performance. This relationship suggests that the elderly subjects wearing these complete dentures for long periods lost stability and retention over time, but that this was probably counteracted by better adaptation. In any case, perhaps these subjects had become less demanding. Poorer masticatory

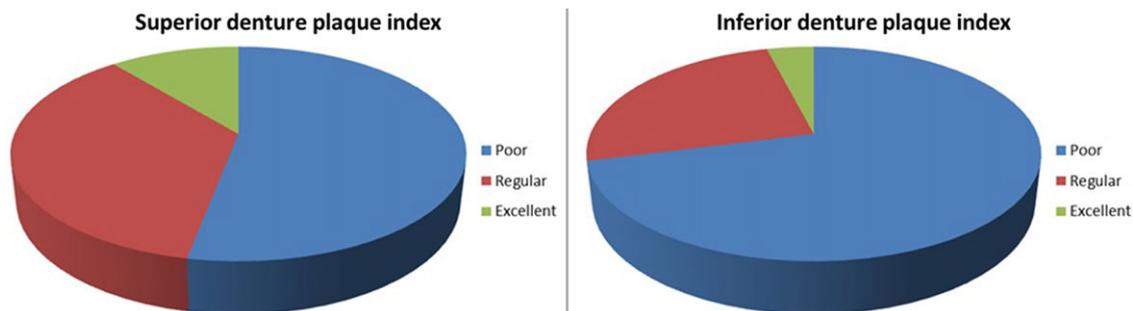


Figure 2 Classification of denture hygiene using the denture plaque index in maxillary denture (left) and mandibular denture (right).

efficiency has been more frequently reported in denture wearers than in subjects with natural dentition, probably due to lower occlusal force.^{31,32}

The prostheses presented very high rates of plaque, suggesting that prosthesis hygiene was generally insufficient. The institutionalized elderly often have less autonomy and poorer oral hygiene than non-institutionalized subjects and may have greater difficulty performing such tasks as cleaning their dentures.³³ However, no relationship was found between denture plaque index and presence of *Candida* in the oral cavity or on the denture. These prosthetic status and maintenance findings suggest that it might be advisable to conduct periodic reviews among the institutionalized elderly to assess any denture treatment requests and to ensure that nursing home staff participate in improving oral and denture hygiene among their patients. The removable denture should be brushed daily to remove biofilm³⁴ and checked frequently by the dentist to help ensure oral and general health.³⁰

To improve preventive measures the practitioner should be aware of the prevalence of *Candida* colonization in denture wearers and of the factors playing major roles in promoting this colonization. In this work, CFU/ml of *Candida* on the denture was significantly related to the presence of oral *Candida*, as in other studies.³⁵ Also, 75% of subjects presented oral *Candida* colonization, a finding similar to other studies performed among elderly denture wearers.^{9,15} Oral *Candida* colonization was primarily related to low saliva pH, sugar consumption and, to a lesser extent, to the presence of faults (fractures or missing components) in the prostheses. The relationship between *Candida* colonization and low saliva pH and sugar consumption was also demonstrated among other denture users,³⁵ but this possible cause-effect relationship should be treated with caution because of the cross-sectional nature of the research. A rich carbohydrate intake yields a low salivary pH and also may increase the proliferation of fungi, which could decrease salivary pH. Therefore, it is difficult to determine whether salivary pH is cause or consequence of colonization by *Candida*.³⁵

Although the presence of faults in the prostheses was significantly related with oral *Candida* colonization, this relationship became insignificant in the multiple regression analysis. Subjects with prostheses with fractures or missing elements constitute a very heterogeneous group, and the increased presence of yeasts could be due to not only to these irregularities but also to the fact that this group tends to be more neglectful. Therefore, repairing the prosthetic faults to prevent *Candida* colonization is not supported by the results of this study, because no prosthetic-related factors were associated with *Candida*.

This work has some limitations. First, the institutions where subjects were recruited were chosen at the authors' convenience and may not have been representative of the overall population. Therefore, the prevalence of *Candida* colonization cannot be extrapolated directly to other groups. Moreover, the sample size was small, and this could limit the power to detect weaker associations (a Type II error).

Conclusions

Although the prosthesis maintenance was insufficient or inadequate, most elderly subjects use a full prosthesis in good

condition. Daily or weekly sugar consumption seems to play a relevant role in the *Candida* colonization of the oral cavity in denture wearers.

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