Original Article

Palatal Inflammation and the Presence of *Candida* in Denture-Wearing Patients

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Abstract

Aim: Denture stomatitis (DS) is a common inflammatory reaction in denture wearers. The severity of palatal inflammation in DS is believed to be related to *Candida* colonization. The present study evaluated the presence of *Candida* at the palatal and the denture surface. The factors associated with DS were also investigated.

Materials and Methods: Eighty-two denture wearers were evaluated for DS based on Newton's classification. The samples were collected from palatal mucosa and the denture surface for *Candida* culture. The predisposing factors associated with DS were also assessed by questionnaire and by oral and dental prosthesis examination.

Results: Thirty patients showed no signs of DS (36.59%), while 52 patients (63.41%) had DS. *Candida* was detected in 81.71% of all patients and specifically in 26.83% and 54.88% of non-DS and DS patients, respectively. The proportion of patients with a large amount of *Candida* at the palatal mucosa in the DS group (40.38%) was higher than in the non-DS group (26.67%) but not significantly different ($P > 0.05$). The amounts of *Candida* among the different Newton types also showed no statistically significant differences ($P > 0.05$). *Candida* was also detected on the denture surface of the non-DS (34.15%) and DS patients (57.32%). The amounts of *Candida* on the denture surface between the two groups showed no statistically significant difference ($P > 0.05$). The predisposing factors related to DS included the absence of occlusal rest and poor denture stability ($P < 0.05$).

Conclusions: In this study, no association between the amount of *Candida* and DS was found. Mycological examination may be useful for the detection of *Candida*-induced DS and management. However, further study is required to establish a protocol for antifungal drugs prescription in the treatment of *Candida*-induced DS among the Newton type.

Keywords: *Candida, denture stomatitis, Newton's classification, palatal inflammation*

Received : 01-09-20
Accepted : 09-02-21
Published : 10-06-21

Introduction

Denture stomatitis (DS) is a common inflammatory process that predominantly involves the palatal mucosa under dentures. *Candida* is believed to play a role in palatal inflammation because of its ability to adhere to oral mucosa or under the dentures, resulting in an accumulation of *Candida* colonies and a biofilm.[1] Predisposing factors such as old age, certain systemic diseases, nighttime denture wearing, the age of the dentures, and smoking have been additionally shown to be involved in DS.[2-4] According to Newton's

Access this article online

Quick Response Code:

Website: www.jispcd.org

DOI: 10.4103/jispcd.JISPCD_368_20

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How to cite this article: Taebunpakul P, Jirawechwongsakul P. Palatal inflammation and the presence of *Candida* in denture-wearing patients. J Int Soc Prevent Communit Dent 2021;11:272-80.

classification, DS can be classified into three types depending on the severity of the disease: (1) Type 1, a focal inflammation with pinpoint hyperemia; (2) Type 2, diffuse erythema of the mucosa covered by the denture; and (3) Type 3, an inflammatory papillary hyperplasia.[5] Newton's Type 1 is usually trauma induced, whereas Newton's Types II and III have multifactorial factors, among which *Candida* infection is the most important.[6] The treatment of DS often requires antifungal agents or antiseptic mouthwash. In addition, the management of DS includes promoting good oral hygiene and eliminating possible related factors.[7] However, it has been suggested that in most cases of DS, the elimination of denture faults, control of oral hygiene, and discontinuous denture wearing are sufficient treatment and the routine use of antifungal or antiseptic agents is unnecessary.[5]

The relationship between the presence of *Candida* and DS has been previously investigated. Several studies have reported a significantly greater prevalence and density of *Candida* species in DS patients compared with those of denture-wearing controls.[8,9] Altarawneh *et al*. reported that patients with DS had higher amounts of *Candida* in their saliva and under the dentures than patients without DS. However, the mucosal *Candida* count on the oral mucosa and cytological hyphae in both the groups were not statistically different.[10] Marinoski *et al*. found more positive microbiological findings on the palate and tongue of DS patients but with no statistically significant differences compared with the healthy control group.[11] Barbeau *et al*. showed that yeast presentation on dentures was not related to whether or not the subjects had stomatitis. A higher prevalence of yeast carriers, yeast colony number, and plaque coverage was found on the dentures of subjects with the most extensive inflammation, regardless of the Newton type.[2] Therefore, it remains inconclusive as to whether the number of *Candida* colonies at the palatal mucosa and denture surface is associated with the Newton type or palatal mucosal conditions. Furthermore, it is not known whether there is any difference between the *Candida* colony number in DS patients and in denture wearers with no palatal inflammation.

In this study, the presence of *Candida* was investigated in relation to the palatal mucosa conditions. The amount of *Candida* under dentures and factors in relation to DS were also studied. The data may help clinicians to provide suitable management for DS.

Materials and Methods

This study included 82 patients with upper removable dentures (complete dentures, acrylic partial dentures, and cast partial dentures) who attended the Department of Oral Surgery and Oral Medicine in the Faculty of Dentistry at Srinakharinwirot University in Bangkok, Thailand, from 2017 to 2018. The study was approved by the Ethics Committee for Human Research, Faculty of Dentistry, Srinakharinwirot University (Approval number DENTSWU-EC16/2560). All the participants provided written informed consent. The inclusion criteria were as follows: (1) aged between 20 and 85 years old; (2) patients had worn upper removable dentures for more than 1 month; and (3) patients did not take any medication that might affect oral bacteria flora, such as antibiotics, antifungals, and corticosteroids or had stopped using the drugs at least 1 month before. The exclusion criteria were patients with uncontrolled diabetes mellitus and autoimmune diseases and those with oral fungal infection.

Data were obtained as follows: first, the patients' case history was taken and a structured questionnaire for data collection was completed by the operator after consultation with the patients. The data analyzed included the patients' demographic data (age, gender, and systemic diseases), smoking habit, prosthesis hygiene, the age of the dentures, and nighttime denture wearing. Next, evidence of DS was assessed by an oral medicine specialist in a clinical setting. The type of palatal inflammation was scored using the classification of DS according to Newton's classification.[12] The severity of palatal inflammation was classified as (1) no DS, no evidence of palatal inflammation; (2) Newton Type I, localized hyperemia at any part of the palatal mucosa in contact with the denture; (3) Newton Type II, diffused erythema without hyperplasia; and (4) Newton Type III, diffuse erythema or generalized erythema with papillary hyperplasia. The dentures were evaluated by direct examination. The data analyzed included the type of denture (complete or partial), the type of denture base (metal or acrylic resin), the denture designs (presence or absence of occlusal rests), and the denture stability. The denture stability was classified as good stability or no stability. The denture stability was defined as the resistance to horizontal forces. The denture was counted as no stability if complete dentures can move 2 mm or more in any direction when the denture is manually moved laterally and partial denture can move 1 mm or more when unilateral or bilateral forces are applied to the denture base. The presence of occlusal rests of removable partial dentures was counted as stated by the previous studies.[13,14] The data about the patient's periodontal status and dental caries were also recorded.

The specimen yeasts were collected from the palatal mucosa (the palate-denture contact area) and the

surfaces of the dentures of 82 patients using a cotton swab. The samples' approach involved gently rubbing a sterile cotton swab over the palatal tissue and the denture surface of each patient and then subsequently cultivated in two separate Sabouraud dextrose agars. The specimen yeasts were then incubated under aerobic conditions at 37°C. The number of colonies was counted after 48 h and was graded into four groups as modified from Gacon *et al*.[15] as follows: (1) no yeast (0 colony); (2) small (1–10 colonies); (3) moderate (11–100 colonies); and (4) large (>100 colonies).

Statistical analysis

Descriptive statistics for the demographic characteristics of the studied population were calculated as a percent distribution and mean and standard deviation. Mann–Whitney U-test or Chi-square test was applied for testing the differences in the demographic characteristics between the groups as appropriate. The differences between the amount of *Candida* colonization and the variables between the DS and non-DS groups and among the Newton types were analyzed by Chi-square test. The associations between DS and the variables were analyzed by bivariate logistic regression, followed by a multivariate logistic regression model for variables with $P < 0.25$. The age, type of dentures, denture stability, nighttime wearing, and occlusal rest were considered as confounding factors and included in multivariate logistic regression analysis as covariates. A value of $P < 0.05$ was considered statistically significant. All the analyses were performed using IBM SPSS Statistics version 20.0 (IBM SPSS Statistics, IBM Corp, Somers, NY, USA).

Results

In total, 82 patients were included in the study, comprising 57 female patients (69.51%) and 25 male patients (30.49%). Their ages ranged between 21 and 83 years old, with a mean age of 59.65 ± 12.26. Sixty percent of patients in the non-DS group and 34.62% of patients in the DS group had systemic diseases, such as diabetes, hypertension, and dyslipidemia. All the patients were taking prescribed medicine for their systemic diseases and their conditions were under the supervision of their physicians. The sex, systemic diseases, smoking habit, denture materials, and average age of the dentures between the two groups showed no statistically significant differences ($P > 0.05$). However, mean age, the type of dentures, the absence of occlusal rest, the denture stability, and nighttime denture-wearing habit were found to be statistically significantly different between the DS and non-DS groups ($P < 0.05$) [Table 1].

Presence of Candida at the palatal mucosa and on the denture surfaces of the denture stomatitis and non-denture stomatitis patients

Seven patients (13.46%) in the DS group and eight patients (26.67%) in the non-DS group had no *Candida* colonization. Ten patients (19.23%) in the DS group and eight patients (26.67%) in the non-DS group had a small amount of *Candida*. A moderate number of *Candida* colonies were found in 14 patients (26.92%) in the DS group and in six patients (20.00%) in the non-DS group. Although the proportion of patients with a large amount of *Candida* colonization in the DS group (40.38%) was higher than in the non-DS group (26.67%), the amount of *Candida* colonization between the two groups was not significantly different ($P = 0.298$) [Table 2].

According to Newton's classification, 12 patients (23.08%) in the DS group could be classified as Newton Type I, while 19 patients (36.54%) were classed as Newton Type II, and 21 patients (40.38%) were Newton Type III. The *Candida* colonization varied from a small amount to a large amount and was detected in all the Newton's types [Table 2]. There was no relationship between the amount of *Candida* detection and Newton's classification ($P = 0.084$). The data implied that the amount of *Candida* was not necessarily associated with the severity of palatal inflammation, based on Newton's classification.

When assessing the number of *Candida* at the denture surface, 47 patients (90.38%) in the DS group and 28 patients (93.33%) in the non-DS group showed positive *Candida* detection at the denture surface, respectively. About 1%–20% of patients in the DS and non-DS groups had a small-to-moderate amount of *Candida* colonization. Most patients showed a large amount of *Candida* colonization, i.e., 75% in the DS group and 60% in the non-DS group [Table 2]. There was no difference in the number of *Candida* colonies at the denture surface between the DS and non-DS groups ($P = 0.207$).

In addition, a large amount of *Candida* colonization on the denture surface was detected in patients with Newton Type II (28.85%) and III (28.85%). Unexpectedly, most patients with Newton Type I also showed a large amount of *Candida* colonization (17.31%), as shown in Table 2. There was no difference in the amount of *Candida* colonization on the denture surface based on Newton's classification ($P = 0.821$). These results suggested that the amount of *Candida* on the denture surface was not associated with the Newton's classification or the severity of palatal inflammation.

Table 1: Demographic characteristics of the studied population

General data	Presence of denture stomatitis (DS group), *n* (%)	Absence of denture stomatitis (non-DS group), *n* (%)	Total, *n* (%)	*P*
Sex				
Male	12 (23.08)	13 (43.33)	25 (30.49)	0.055
Female	40 (76.92)	17 (56.67)	57 (69.51)	
Age (years), mean±SD	57.86±10.79	62.7±14.08	59.65±12.26	0.020
Systemic diseases				
Healthy	34 (65.38)	12 (40.00)	46 (56.10)	0.065
Hypertension	7 (13.46)	6 (20.00)	13 (15.85)	
Diabetes mellitus	0 (0.00)	3 (10.00)	3 (3.66)	
Dyslipidemia	5 (9.62)	3 (10.00)	8 (9.76)	
Others	6 (11.54)	6 (20.00)	12 (14.63)	
Smoking habit				
Yes	4 (7.69)	3 (10)	7 (8.54)	0.719
No	48 (92.31)	27 (90)	75 (91.46)	
Type of dentures				
Upper complete denture	6 (11.54)	9 (30.00)	15 (18.29)	0.037
Upper partial denture	46 (88.46)	21 (70.00)	67 (81.71)	
Denture materials				
Acrylic	38 (73.08)	17 (56.67)	55 (67.07)	0.128
Metal	14 (26.92)	13 (43.33)	27 (32.93)	
Occlusal rest*				
Presence	13 (28.26)	13 (61.90)	26 (38.81)	0.009
Absence	33 (71.74)	8 (38.10)	41 (61.19)	
Stability of dentures				
Good	19 (36.54)	21 (70)	40 (48.78)	0.004
No	33 (63.46)	9 (30)	42 (51.22)	
Average age of dentures (months), mean±SD	92.70±91.48	60.18±68.82	80.56±84.74	0.096
Nighttime wearing				
Yes	18 (34.62)	4 (13.33)	22 (26.83)	0.036
No	34 (65.38)	26 (86.67)	60 (73.17)	

*Only patients wearing partial dentures were included. DS=Denture stomatitis, SD=Standard deviation

Presence of Candida at the palatal mucosa and on the denture surfaces of the denture stomatitis and non-denture stomatitis patients categorized by the denture condition

Nineteen patients (36.54%) in the DS group and 21 patients (70.0%) in the non-DS group showed good denture stability. Thirty-three patients (63.46%) in the DS group and 9 patients (30.00%) in the non-DS group had poor denture stability [Figure 1a]. The percentage of patients with poor denture stability was higher in the DS group than in the non-DS group ($P = 0.004$).

Regarding the relationship between the denture status and Newton's classification, the highest percentage of DS patients with good denture stability was found in Newton Type I. Besides, most DS patients with Newton Type III had poor denture stability, as shown in Figure 1b. There was no difference between the number of patients with good-to-poor denture stability among the Newton types ($P = 0.064$). In addition, the amount of *Candida* colonization at the palatal aspect and on the denture surface was not associated with the denture conditions in both the groups ($P > 0.05$) [Table 3]. These results suggested that the dental denture stability was related to DS; however, the amount of *Candida* colonization was not associated with the denture stability.

Factors predisposing to denture stomatitis

Predisposing factors that may influence the occurrence of DS including sex, age of patients, systemic diseases, smoking status, denture design, area of missing teeth, denture materials, denture stability, nighttime denture wearing, age of dentures, denture hygiene, periodontal status, and dental caries were assessed. At the bivariate level, the results showed that age of patients 40–59 years old ($P = 0.014$, odds ratio [OR] = 3.704), age of patients ≥60 years old ($P = 0.019$, OR = 0.312), patients with systemic diseases ($P = 0.028$, OR = 2.833), type of dentures ($P = 0.043$, OR = 3.286), absence of occlusal rest ($P = 0.011$, OR = 0.242), poor denture stability ($P = 0.004$, OR = 0.247), nighttime denture wearing ($P = 0.043$, OR = 3.441), dentures older than

Table 2: Amount of *Candida* colonization at the palatal mucosa and on the denture surface between the denture stomatitis group and the nondenture stomatitis group

Number of *Candida* colonies	Palatal mucosa					
	DS group				Non-DS group (*n*=30, 100%), *n* (%)	*P*
	Newton Type I (*n*=12, 23.08%), *n* (%)	Newton Type II (*n*=19, 36.54%), *n* (%)	Newton Type III (*n*=21, 40.38%), *n* (%)	Total DS (*n*=52, 100%), *n* (%)		
No yeast	0	5 (9.62)	2 (3.85)	7 (13.46)	8 (26.67)	0.298[a]
Small number of yeasts	3 (5.77)	4 (7.69)	3 (5.77)	10 (19.23)	8 (26.67)	0.084[b]
Moderate number of yeasts	1 (1.92)	4 (7.69)	9 (17.30)	14 (26.92)	6 (20.00)	
Large number of yeasts	8 (15.38)	6 (11.54)	7 (13.46)	21 (40.38)	8 (26.67)	
Number of *Candida* colonies	**Denture surface**					
	DS group				Non-DS group (*n*=30, 100%), *n* (%)	*P*
	Newton Type I (*n*=12, 23.08%), *n* (%)	Newton Type II (*n*=19, 36.54%), *n* (%)	Newton Type III (*n*=21, 40.38%), *n* (%)	Total DS (*n*=52, 100%), *n* (%)		
No yeast	0	2 (3.85)	3 (5.77)	5 (9.61)	2 (6.67)	0.207[c]
Small number of yeasts	2 (3.85)	1 (1.92)	2 (3.85)	5 (9.61)	4 (13.33)	0.821[d]
Moderate number of yeasts	1 (1.92)	1 (1.92)	1 (1.92)	3 (5.77)	6 (20.00)	
Large number of yeasts	9 (17.31)	15 (28.85)	15 (28.85)	39 (75.00)	18 (60.00)	

[a]No significant difference in the number of *Candida* colonies between the DS and non-DS group at the palatal mucosa, [b]No significant difference in the number of *Candida* colonies among the Newton types at the palatal mucosa, [c]No significant difference in the number of *Candida* colonies between DS and non-DS group on the denture surface, [d]No significant difference in the number of *Candida* colonies among Newton types on the denture surface. DS=Denture stomatitis

4 years old (P = 0.007, OR = 3.733), and dentures older than 5 years old (P = 0.020, OR = 3.286) had a significantly greater risk of DS ($P < 0.05$). However, in the final multivariate logistic regression model, only poor denture stability (P = 0.031, Adjusted odds ratio [AOR] = 0.252) and absence of occlusal rest (P = 0.034, AOR = 0.296) significantly predicted the DS, as shown in Table 4.

Discussion

DS is an inflammatory process that involves the palatal mucosa and dentures. It exhibits a multifactorial etiology. Various factors including trauma caused by ill-fitting dentures, poor denture hygiene, nighttime wearing of dentures, accumulation of denture plaque, and bacterial and fungal infections have been reported to be involved in the disease.[4,7] It is known that the presence of *Candida* in denture plaque is one of the most important factors in the development of DS.[16] Although *Candida* has been shown to be associated with DS, no conclusive study has confirmed the amount of *Candida* on palatal tissue or on denture surfaces, according to Newton's classification. Newton Type I is believed to be related to trauma caused by ill-fitting dentures and does not require an antifungal prescription, while antifungal drugs are given to patients with Newton Types II and III.[17,18] Therefore, data on *Candida* colonization at the palatal mucosa and on the tissue surface of dentures in relation to Newton's classification would be informative for clinicians for DS management.

Previous studies have reported *Candida* colonization at the palatal mucosa of non-DS subjects in 45%–53% of cases.[15,19] The current study showed the presence of *Candida* colonization at the palatal mucosa, found in both the DS and non-DS groups at rates of 54.88% and 26.83%, respectively. The number of *Candida* colonies was not related to the severity of palatal inflammation according to Newton's classification [Table 2]. This was also observed by Gauch *et al*., who showed that the colonization of *Candida* at the palatal mucosa was not associated with the severity of the palatal inflammation. They reported 36.11%, 22.22%, and 13.88% cases of *Candida* colonization in DS patients with Newton Types I, II, and III, respectively.[20] These data suggest that the clinical presentation of mild palatal inflammation can be related to a high percentage of *Candida* detection. Future clinical studies to evaluate effects of antifungal drug on the different types of DS maybe helpful in establishing a protocol for DS management.

When assessing the amount of *Candida* colonization on the denture surface, we observed that the number of *Candida* colonies on the denture surface was not associated with DS or the Newton type. Previous studies also reported that there was no difference between the amount of *Candida* detected in patients with and without DS.[21] In contrast, Barbeau *et al*. found that the presence of yeast on dentures was increased in Newton Type III compared with Newton Types I and II. They suggested that the amount of yeast under the dentures was probably related to an extensive inflammation in DS.[2] The

Table 3: Number of *Candida* colonies at the palatal mucosa and on the denture surface of the denture stomatitis group and the nondenture stomatitis group categorized by the denture condition

Number of *Candida* colonies	Denture stability in the DS group (*n*=52, 100%), *n* (%)					
	Palatal mucosa			Denture surface		
	Yes (*n*=19, 36.54%), *n* (%)	No (*n*=33, 63.46%), *n* (%)	*P*	Yes (*n*=19, 36.54%), *n* (%)	No (*n*=33, 63.46%), *n* (%)	*P*
No yeast	3 (5.77)	4 (7.69)	0.591	3 (5.77)	2 (3.85)	0.400
Small number of yeasts	4 (7.69)	6 (11.54)		3 (5.77)	2 (3.85)	
Moderate number of yeasts	3 (5.77)	11 (21.15)		1 (1.92)	2 (3.85)	
Large number of yeasts	9 (17.31)	12 (23.08)		12 (23.08)	27 (51.92)	
Number of *Candida* colonies	**Denture stability in the non-DS group (*n*=30, 100%)**					
	Palatal mucosa			Denture surface		
	Yes (*n*=21, 70.00%), *n* (%)	No (*n*=9, 30.00%), *n* (%)	*P*	Yes (*n*=21, 70.00%), *n* (%)	No (*n*=9, 30.00%), *n* (%)	*P*
No yeast	6 (20.00)	2 (6.67)	0.933	1 (3.33)	1 (3.33)	0.794
Small number of yeasts	5 (16.67)	3 (10.00)		3 (10.00)	1 (3.33)	
Moderate number of yeasts	4 (13.33)	2 (6.67)		5 (16.67)	1 (3.33)	
Large number of yeasts	6 (20.00)	2 (6.67)		12 (40.00)	6 (20.00)	

DS=Denture stomatitis

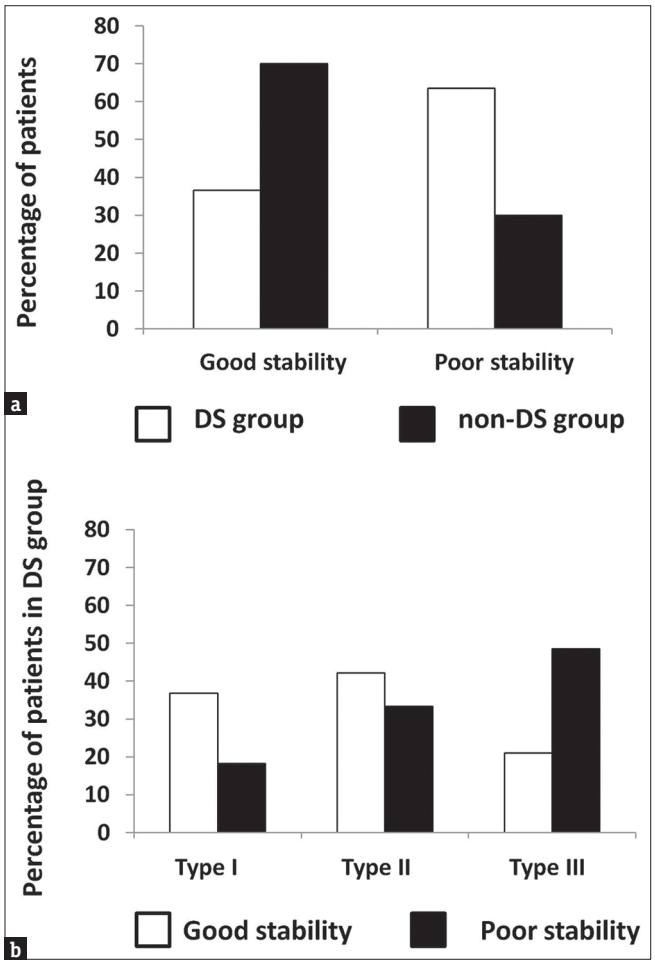

Figure 1: (a) Percentage distribution of patients according to denture stability. (b) Percentage of denture stomatitis patients with good or poor denture stability according to Newton's classification. DS = Denture stomatitis

possible explanation for the different results among studies could be that the various factors including denture condition, denture materials, the age of the dentures, and denture hygiene related to the studied population in each study can affect the amount of *Candida* colonization on the denture surface.

Several studies reported that sex, age of patients, systemic diseases, smoking, denture materials, poor denture stability, nighttime wearing, and the age of the dentures play a role in the occurrence of DS.[22-25] Among the predisposing factors that were evaluated in this study, only poor denture stability and the absence of occlusal rest were predicted to DS ($P < 0.05$). DS is multifactorial in nature, with trauma could act as a factor that favors the colonization of the yeast. The trauma may originate from poor denture stability. Prior studies have shown an increase in *Candida* colonization in patients with poorly fitting dentures.[23,26] Furthermore, in this study, the absence of occlusal rest was also related to DS ($P < 0.05$). The pressure distribution on the residual ridge beneath the removable partial denture base was shown to be dependent on the occlusal rest designs.[13] It could be that the absence of occlusal rest affected the pressure distribution pattern beneath the denture base and probably increased risk of trauma to the denture bearing area.

We found no significant relationship between DS and classic risk factors such as the age of dentures and nighttime wearing. The possible explanation could be that the sample size in this study was small. It could affect the power to detect weaker associations. While this study provides useful data regarding the factors associated with DS, the limitation of this study is that all factors related to DS cannot be included. These factors comprise the nutritional status, alcohol consumption, dental biofilm accumulation, hyposalivation, and decrease of salivary pH.

Table 4: Predisposition factors associated with denture stomatitis

Factors (*n*; %)	Presence of denture stomatitis (DS group), *n* (%)	Absence of denture stomatitis (non-DS group), *n* (%)	Bivariate logistic regression analysis (*P*, OR, 95% CI)	Multivariate logistic regression analysis[a] (*P*, AOR, 95% CI)
Sex (female)				
Yes	40 (76.92)	17 (56.67)	0.058, 0.392, 0.149-1.033	0.109, 0.363, 0.105-1.255
No	12 (23.08)	13 (43.33)		
Age of patients (years)				
20-39				
Yes	3 (5.77)	2 (6.67)	0.870, 0.857, 0.135-5.443	
No	49 (94.23)	28 (93.33)		
40-59				
Yes	25 (48.08)	6 (20.00)	0.014, 3.704, 1.300-10.552	0.473, 0.393, 0.031-5.030
No	27 (51.92)	24 (80.00)		
≥60				
Yes	24 (46.15)	22 (73.33)	0.019, 0.312, 0.117-0.827	
No	28 (53.85)	8 (26.67)		
Systemic diseases				
Yes	18 (34.62)	18 (60.00)	0.028, 2.833, 1.121-7.162	0.076, 3.002, 0.890-10.123
No	34 (65.38)	12 (40.00)		
Smoking				
Yes	4 (7.69)	3 (10.00)	0.719, 0.750, 0.156-3.603	
No	48 (92.31)	27 (90.00)		
Type of dentures				
Upper complete denture	6 (11.54)	9 (30.00)	0.043, 3.286, 1.035-10.427	0.122, 3.373, 0.722-15.749
Upper partial denture	46 (88.46)	21 (70.00)		
Free end partial denture*				
Yes	11 (23.91)	7 (33.33)	0.422, 1.591, 0.513-4.936	
No	35 (76.09)	14 (66.67)		
Occlusal rest*				
Presence	13 (28.26)	13 (61.90)	0.011, 0.242, 0.082-0.721	0.034, 0.296, 0.096-0.912
Absence	33 (71.74)	8 (38.10)		
Area of missing teeth*				
Anterior teeth				
Yes	16 (34.78)	7 (33.33)	0.908, 1.067, 0.358-3.177	
No	30 (65.22)	14 (66.67)		
Posterior teeth				
Yes	8 (17.39)	3 (14.29)	0.751, 1.263, 0.299-5.334	
No	38 (82.61)	18 (85.71)		
Anterior and posterior teeth				
Yes	22 (47.83)	11 (52.38)	0.730, 0.833, 0.296-2.342	
No	24 (52.17)	10 (47.62)		
Acrylic dentures				
Yes	38 (73.08)	17 (56.67)	0.131, 2.076, 0.805-5.351	0.461, 1.593, 0.462-5.490
No	14 (26.92)	13 (43.33)		
Poor denture stability				
Yes	33 (63.46)	9 (30)	0.004, 0.247, 0.094-0.647	0.031, 0.252, 0.072-0.882
No	19 (36.54)	21 (70)		
Age of denture (years)				
Age of dentures >3				
Yes	34 (65.38)	14 (46.67)	0.100, 2.159, 0.863-5.041	
No	18 (34.62)	16 (53.33)		

Contd...

Table 4: Contd...

Factors (*n*; %)	Presence of denture stomatitis (DS group), *n* (%)	Absence of denture stomatitis (non-DS group), *n* (%)	Bivariate logistic regression analysis (*P*, OR, 95% CI)	Multivariate logistic regression analysisa (*P*, AOR, 95% CI)
Age of dentures >4				
Yes	32 (61.54)	9 (30.00)	0.007, 3.733, 1.429-9.752	0.055, 0.298, 0.086-1.028
No	20 (38.46)	21 (70.00)		
Age of dentures >5				
Yes	26 (50)	7 (23.33)	0.020, 3.286, 1.202-8.982	
No	26 (50)	23 (76.67)		
Nighttime denture wearing				
Yes	18 (34.62)	4 (13.33)	0.043, 3.441, 1.039-11.399	0.392, 1.929, 0.428-8.698
No	34 (65.38)	26 (86.67)		
Irregular cleaning				
Yes	1 (1.92)	2 (6.67)	0.300, 3.643, 0.316-41.976	
No	61 (98.08)	28 (93.33)		
Cleaning method				
Toothbrush only				
Yes	12 (23.08)	9 (30.00)	0.490, 0.700, 0.254-1.927	
No	40 (76.92)	21 (70.00)		
Toothbrush with chemical products				
Yes	10 (19.23)	7 (23.33)	0.659, 0.782, 0.263-2.330	
No	42 (80.77)	23 (76.67)		
Toothbrush with toothpaste				
Yes	30 (57.69)	14 (46.67)	0.336, 1.558, 0.631-3.848	
No	22 (42.31)	16 (53.33)		
Gingival diseases*				
Yes	23 (50.00)	10 (47.62)	0.857, 1.100, 0.391-3.091	
No	23 (50.00)	11 (52.38)		
Periodontal diseases*				
Yes	17 (36.96)	3 (14.29)	0.070, 3.517, 0.902-13.718	0.296, 2.229, 0.496-10.025
No	29 (63.04)	18 (85.71)		
Dental caries*				
Yes	31 (67.39)	10 (47.62)	0.127, 2.273, 0.791-6.530	0.511, 1.490, 0.454-4.896
No	15 (32.61)	11 (52.38)		

*Only patients wearing partial dentures were included, [a]Odd ratio adjusted for sex, age of patients≥40 years, systemic diseases, type of dentures, acrylic dentures, poor denture stability, age of denture>4 years, nighttime denture wearing, occlusal rest, periodontal diseases, dental caries. DS=Denture stomatitis, OR=Odds ratio, CI=Confidence interval, AOR=Adjusted odds ratio

Therefore, it would be beneficial to address these factors in the further study.

Conclusions

In this study, a large amount of *Candida* colonization at the palatal mucosa was found in a higher proportion of the DS group than in the non-DS group. However, the association was not statistically significant. These data suggest that the degree of palatal inflammation may not be necessarily related to the amount of *Candida* detection in removable denture wearers. Therefore, mycological examination may be useful for the detection of *Candida*-induced DS and management. However, further study is required to establish a protocol for the prescription of antifungal drugs in the treatment of *Candida*-induced DS among the Newton type.

Acknowledgments

The authors thank Dr. Ornuma Charoensuk for advice on statistical analysis.

Financial support and sponsorship

This research was supported by the Faculty of Dentistry, Srinakharinwirot University (2017).

Conflicts of interest

There are no conflicts of interest.

Author contributions

PT and PJ were involved in study conception, data collection, data acquisition and analysis, data interpretation, manuscript writing. All authors

approved the final version of the manuscript for publication.

Ethical policy and institutional review board statement

The research project was approved by the Ethical Committee for Research in Human Subjects at Srinakharinwirot University, no. DENTSWU-EC16/2560.

Patient declaration of consent

The authors certify that they have obtained all appropriate patient consent forms.

Data availability statement

The data set used in the current study is available on request from Pimporn Jirawechwongsakul/email: pimpornr@g.swu.ac.th

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